

V F Gladiolus

NEW YORK  
BOTANICAL  
GARDEN

December, 1916

Extension Bulletin 10

# Cornell Extension Bulletin

Published by the New York State College of Agriculture  
at Cornell University, Ithaca, New York

A. R. Mann, Acting Director of Extension Service

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## Gladiolus Studies—II

### Culture and Hybridization of the Gladiolus

Alfred C. Hottes



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## PREFACE

The data for this bulletin are based on the results of four years of work in the trial grounds of the American Gladiolus Society, and on conversations and correspondence with many gladiolus experts. In 1913 question blanks were mailed to members of the American Gladiolus Society and to some of the growers in Europe. Much information was derived from this questionnaire. The writer wishes to thank the following for their assistance in this work:

Mrs. K. Atkinson, The Flagstaff, Locksheath, Southampton, England  
Mrs. A. H. Austin, Wayland, Ohio  
B. C. Auten, Carthage, Missouri  
G. B. Babcock, Jamestown, New York  
J. G. Baker, Kew Gardens, England  
E. T. Barnes, Spencer, Indiana  
J. M. Bassett, Hammonton, New Jersey  
C. Betscher, Canal Dover, Ohio  
G. D. Black, Independence, Iowa  
A. P. Bonvallet, Wichert, Illinois  
Ernest Braunton, Los Angeles, California  
C. W. Brown, Ashland, Massachusetts  
W. C. Bull, Ramsgate, England  
Luther Burbank, Santa Rosa, California  
Montague Chamberlain, Wellesley, Massachusetts  
Madison Cooper, Calcium, New York  
Arthur Cowee, Berlin, New York  
Matthew Crawford, Cuyahoga Falls, Ohio  
N. L. Crawford, Grafton, Ohio  
E. H. Cushman, Sylvania, Ohio  
E. N. Fischer, Jamaica Plain, Massachusetts  
E. T. Flanagan & Sons, Belleville, Illinois  
Maurice Fuld, New York City  
L. M. Gage, Wellesley, Massachusetts  
H. H. Groff, Simcoe, Ontario  
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Dr. C. Hoeg, Decorah, Iowa  
R. E. Huntington, Painesville, Ohio  
J. B. Hutchinson, Haddonfield, New Jersey  
E. H. Krelage, Haarlem, Holland  
A. E. Kunderd, Goshen, Indiana  
E. R. Macomber, Woodfords, Maine  
J. L. Moore, Northboro, Massachusetts  
J. F. Munsell, Ashtabula, Ohio  
H. H. W. Pearson, National Botanic Gardens, Cape Town, South Africa  
H. A. Richardson, Woodfords, Maine



De Ruyter & Hogewonig, Noordwijk, Holland  
S. E. Spencer, Woburn, Massachusetts  
E. E. Stewart, Brooklyn, Michigan  
C. S. Tait, Brunswick, Georgia  
F. C. Thomann, Rochester, New York  
B. H. Tracy, Wenham, Massachusetts  
C. G. van Tubergen, jr., Haarlem, Holland  
W. Van Fleet, Glenn Dale, Maryland  
W. Watson, Kew Gardens, England  
B. F. White, Terryville, Connecticut  
W. W. Wilmore, jr., Wheat Ridge, Colorado  
Henry Youell, Syracuse, New York  
C. F. van Zanten, Hillegom, Holland  
C. Zeestraten & Sons, Oegstgeest, Holland

The writer has had valuable correspondence with many others, and regrets that each person may not be given due credit.

ALFRED C. HOTTES

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INDOOR TYPE OF GLADIOLI  
NANUS VARIETIES: PEACH BLOSSOM (PINK)  
AND MODESTY (WHITE)



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## GLADIOLUS STUDIES—II

### CULTURE AND HYBRIDIZATION OF THE GLADIOLUS

ALFRED C. HOTTES

#### THE GLADIOLUS AS A CUT FLOWER AND AS A GARDEN SUBJECT

"Gladioli to cut, cannas for out-of-doors," writes B. C. Auten. In the same strain ex-President Hendrickson (1911),<sup>1</sup> of the American Gladiolus Society, writes:

The gladiolus is essentially a cut flower, and will rival nearly any other in keeping qualities, as they can be kept fresh and beautiful after cutting for a period of five to ten days by changing the water daily and removing each day the withered blooms, it also helps to nip off the ends of the spike when changing the water. If the spikes are cut when the first two or three flowers have opened, the entire stalk will open out for us after it has been put in water. They are very adaptable to send to friends at a distance, as they will arrive in excellent condition if just a little pains are taken when shipping. If we want to do this the spikes should be cut when the first flower opens, and put in water in the cellar or cool place for two or three hours, so they can take up a good drink, after which they will stand the journey of two or three days, and when placed in water will quickly respond and unfold their gorgeous petals.

Miss Re Shore (1911) speaks further of the gladiolus as a cut flower. She writes that they are "best with their own foliage and in tall, slender, clear glass vases. . . . One special feature to their credit is that they do not fall to pieces in the house."



PHOTOGRAPH LENT BY MRS. B. H. TRACY

FIG. 10. ROUGE TORCH

Soft creamy yellow in color with a brilliant red tongue on the lower petals. This is one of the slender-stemmed varieties, and lends itself particularly well to all manner of arrangement

<sup>1</sup> Dates in parenthesis refer to bibliography, page 259.



Groff (1906 b) gives the following excellent suggestions for the care of the cut blooms:

Cut the spike when the first flower opens and place in water without overcrowding. Remove the terminal buds soon, as this checks stalk development and throws the strength into the larger and earlier maturing flowers. The end of the stalk should be shortened and the water renewed daily with frequent cleansing of the vases. In shortening the stalk cut diagonally, to insure free absorption of water by the spike without the contamination and obstruction, caused by sediment, if cut at a right angle.

. . . Blooming the spikes in the shade of room or piazza modifies the field colors, from bright shades and tints to delicate flushes and shadings, and also reduces the latter types to the faintest tinge of color or white. . . .

The advent of my new hybrids producing the most intense and deep shades of violet, purple, crimson and scarlet . . . makes it desirable that these brilliant combinations be preserved when the spikes are cut for decorative purposes.

To ensure this most desirable result, place the vases of these highly colored types in the early morning sun for an hour or two daily, preferably after renovation and renewal of the water. . . .

\* \* \* \* \*

One of the causes of the popularity of the gladiolus as a decorative flower, is the fact that it has no perfume, as there are few flowers used for this purpose that are not distasteful to some one — particularly in closed rooms — either from personal preference or painful association.

Where the pollen proves irritating to the tissues of the respiratory organs . . . the anthers may be easily pinched out during the daily renovation. . . . This removal of the anthers is desirable in the highly colored types, . . . where the shed pollen dulls the brilliancy of the petals on which it may fall.

The consideration of the gladiolus as a cut flower is not complete without a discussion as to the proper way to cut a spike. A corm is a thickened base of a stem, and this being the case there must be leaves remaining to nourish and feed this corm. Thus, in cutting the blooms, two or three leaves should always be left on the plant. The spike may be cut with a short enough stem to accommodate this balance, or one may merely cut into the leaves and through the stem, taking only enough leaves to be used in the bouquets. Cutting the stems too long is a common mistake of the amateur.

The spikes are being used more and more in the making of floral designs, for bases of standing wreaths, and in large clusters for sprays. The individual flowers have in many cases taken the place of lilies and orchids in wedding and presentation bouquets and baskets. The graceful spikes of the *Gladiolus nanus* varieties are especially valuable for corsage bouquets or for small baskets, or arranged in flower holders, or japanas, placed in bowls of water. If these varieties were better known and appreciated, the demand would be great. Many of the large flower shops use them when they can be obtained. As a summer flower for large decorations the gladiolus is unexcelled, especially when placed in large vases or hampers and used on porches or yachts, or in hotels, summer resorts, churches, or automobiles.

Excellent results are obtained by careful selection of the receptacle for the flowers. Wall vases containing a few spikes, carefully arranged,



are sure to be interesting. Plain vases and simple baskets are to be preferred to highly decorated ones, since the gladiolus is gay in itself. Many



PHOTOGRAPH LENT BY MRS. B. H. TRACY

FIG. II. DAYBREAK

A charming rose-bowl decoration. These spikes had been cut for a week. A suggested use for spikes

of the individual spikes are so beautiful that if arranged alone in a vase their separate charms are more effective than if more than one are used.



Curved spikes are indispensable for some of the most effective arrangements, especially in huge hampers. Large vases of one variety, such as *Brenchleyensis*, Hazel Harvey, Mrs. Francis King, and some other darker varieties, are effective when combined with the variegated-leaved corn (*Zea mays* var. *japonica*). Mrs. B. H. Tracy deserves much credit for popularizing this flower in a decorative way by exhibiting the blooms properly, for she has made many advances in arrangement over the ordinary method of using uninteresting vases and inappropriate receptacles.

In addition to the value of the gladiolus as a cut flower, it is especially attractive also as a garden subject when planted thickly in clumps or beds. Soil well prepared will allow a good development of the spikes, even if the corms have been very closely set. Unless used in masses, the plants are likely to appear rather spindling; but when properly planted, the bed of gladioli is one of the most showy features of summer or autumn. The beds so used need not be for gladioli exclusively, but may have some annuals or perennials growing with them. Good combinations result from planting early in the spring a bed of white *Phlox Drummondii*, and later using the gladiolus *America* between the plants; or pink phlox and the gladiolus *Rochester White* may be combined. Especially effective is the combination of gladiolus with the summer hyacinth (*Galtonia* [= *Hyacinthus*] *candicans*), the tall spikes of white bloom and the bold foliage of the latter seeming especially harmonious. No better combination is available than that which results from the planting of some corms among irises, which have leaves in perfect harmony with the gladiolus and which bloom in a widely separated season.

The stately spikes are attractive when used in large clumps of one variety among shrubbery. Care must be taken not to place the plants within the detrimental influence of large tree roots or in too much shade. Gardeners frequently start certain good varieties in boxes or pots, and, when in full growth, transplant them in clumps to places in the border where a bit of color is needed after some other plants have failed.

Miss Andres (1914) advocates combining columbines, petunias, and gladioli, not only because of their colors, but also, and mainly, for the excellent succession of bloom provided.

Bold masses of *Gladiolus primulinus* hybrids (fig. 12) are extremely effective, since their various colors blend so well. Blue Jay and Baron Joseph Hulot are violet and blue varieties which harmonize well with yellow varieties, such as Golden King or Sulphur King.

Excellent combinations have been made with roses and gladioli. The June-flowering roses are best for this purpose, since they are entirely out of season when the gladiolus is at its best.

The accusation that the gladiolus is stiff and formal does not now hold. The modern gladiolus is stately and dignified, and deserves prominent consideration and a place in every home or palace. It is a regal flower available to all.

### SOILS FOR THE GLADIOLUS

Soil technologists emphasize the fact that a proper physical condition of the soil is quite as important for the growth of a crop as is the richness; in other words, the tilth and handling of the soil is as much to be considered as the actual chemical analysis. Various opinions have prevailed, and still persist, regarding proper garden soil for gladioli.

Dombrain (1873) mentions the former belief that there was no soil too poor for the gladiolus, and states that advice was given that if the soil were not poor enough it had better be charred or burned to make it so. However, as he says, experience proved this to be unsound, and a rich soil was considered by no means unsuitable. Then came the high pressure treatment; heaps of manure in the soil, heavy top-dressings above it, and then what blooms we shall have! But the strongest advocates of this system found that they had been a little too fast, and that although they obtained fine blooms, they lost their bulbs. Since then a more moderate system has been practised.

The depth of planting will obviously differ with the soil. The lighter the soil, the deeper the corms may be planted. Deep planting is especially successful in dry seasons, because the roots are in cool, moist soil. Usually, with deep planting, staking will be unnecessary. There is danger in deep planting in a heavy,



FIG. 12. PRIMULINUS SEEDLINGS

The *primulinus* seedlings include a group of graceful varieties all of which have distinctly hooded blooms. The colors are charming, following the influence of the clear primrose-yellow of the *primulinus* parent as well as of the delicate intermediate colors possessed by other parents, which in many cases are *Lemoinei*, *Childsi*, or *nanceianus* varieties



moisture-holding soil. The soil may be too wet and may cause a rotting of the young shoots as well as the corms. If the soil is too clayey the shoots may not have strength enough to emerge, or they may be twisted, and thus made unable to produce a good, strong spike. The following data are valuable for showing the various practices and opinions as to the best soil for proper growth of the plants:

Grower	Depth to plant (inches)	Type of soil	Soil preferred
Atkinson.....	4	Light loam.....	Light loam, good bottom drainage
Austin.....	4	Sandy loam.....	Sandy loam
Auten.....	3-4	Prairie.....	No limestone nor dressings of lime
Babcock.....	3-5	Gravelly.....	
Barnes.....	4	Sandy loam.....	Sandy loam
Bassett.....	4-6	Light and sandy.....	
Betscher.....	3-6	Sandy loam.....	Good clay loam, but dependent on season
Black.....	2-6	Sandy loam.....	Sandy loam
Bonvallet.....	4	Sandy.....	Sandy loam
Brown.....	4-6	Sandy loam.....	Considerable sand
Bull.....	4	Stiff loam.....	Stiff loam
Burbank.....	6	Sand and heavy clay.	Sandy loam; new soil
Crawford, M.....	4	Heavy clay loam....	Sandy loam
Crawford, N. L.....	5	Loam and sandy loam	Loam for large corms; for the smaller, much lighter soil
Dombrain.....	4	.....	Medium
Fischer.....	4-6	Light loam.....	
Flanagan.....	5-6	Clay loam.....	Rich, level, sandy
Fuld.....	6	Heavy clay.....	Heavy clay
Gage.....	6	Sandy loam.....	Sandy loam
Hoeg.....	5	Dark clay loam.....	
Huntington.....	3-4	Light.....	Heavy
Hutchinson.....	4	Light loam.....	Light loam, but damp
Macomber.....	2-4	Sandy loam.....	Light loam, not heavy
Moore.....	4	Sandy loam.....	Rather light to heavy
Munsell.....	4-5	Sandy loam.....	
Rand.....	2-4	.....	
Re Shore.....	6-8	Sandy loam.....	
Richardson.....	6	Sandy loam.....	Light loam
de Ruyter & Hogewonig .....		1½ inches sand.....	Sandy for most; plants are healthier
Spencer.....	4-6	Sandy loam.....	Sandy loam
Stewart.....	3-5	Gravelly loam.....	Loam
Tait.....	4-7	Sand.....	Sandy loam
Thomann.....	4-6	Light, not very sandy	Rich, deep, well-drained, not too heavy
Tracy.....	6	Gravelly.....	Gravelly or sandy
Van Fleet.....	4-6	.....	Any soil good for potatoes
White.....	3-6	Sandy loam.....	Moist loam, porous subsoil
Wilmore.....	6	Sandy loam.....	Well-drained swamp with sandy loam bottom
van Zanten.....	2	Sand.....	Clay for some, sand for others
Zeestraten.....	3	Sandy.....	Sandy soil, well drained

It is seen that many of the growers consulted prefer a sandy loam. E. H. Cushman says that the gladiolus does equally well on any soil, if given the proper culture. The commercial grower, however, who must produce stock at a profit, will choose soil as nearly ideal as possible—in other words, a light loam.

### FERTILIZERS AND THEIR USE

Fertilizers applied to plants are valuable in proportion to the amount of the needed plant-food that is available. Only such nutriment as is soluble can be taken into the plant, and therefore much food is locked up, or unavailable. Some fertilizers are applied for their value in unlocking, or freeing, plant-food, rather than for their actual fertilizer value.

The production of gladiolus corms is very analagous to the production of a crop of potatoes. A good standard special potato fertilizer is therefore recommended. Such a fertilizer will be rich in phosphoric acid and potash. The gladiolus is a rank grower and a gross feeder, and responds to any treatment that increases the available plant-food. Either manures or chemicals may be applied as a fertilizer, both of which are valuable in their way. The first kind, stable manure, is of prime importance, but each year it is getting more difficult to obtain this. When possible it is well to use cow, pig, sheep, or poultry manure, rather than that from the horse. It must be borne in mind that sheep manure and poultry manure are especially strong and cannot be applied too abundantly without danger of causing too great vegetative growth, watery corms, or perhaps even a burning of the whole plant. It is thought that the gladiolus is very susceptible to the presence of any manure in contact with its roots. All manure, then, should be thoroughly incorporated with the soil, rather than left in lumps. This is best accomplished by application in the autumn.

Burrell (1898) writes:

I avoid as much as possible adding anything to the soil likely to create an excess of humus, which is harmful, in generating disease. It is generally supposed that gladioli require a light sandy soil, but . . . I would prefer to plant in heavy yellow loam. . . . Corms raised on well-prepared heavy loam I find have greater life and vigour than the large, soft, watery ones from light sandy soils, and that the size of flower and spike in no way suffers on the former, I think our exhibits over a long number of years fully bear out.

The general opinion has been that a sour soil is injurious to the gladiolus, but Chamberlain (1914 b) doubts this. He says: "Some plants thrive best in a sour soil, and is Mr. [ . . . . . ] dead sure that the gladiolus is not one of these? I have heard an experienced grower assert that the gladiolus prefers the acidity."



All humus-making material produces acidity when rotting in the soil. This can be easily overcome, or neutralized, by the use of lime. B. C. Auten is emphatic in his denunciation of lime. He writes: "Two years' planting upon ground limestone nearly put me out of business." Cooper (1914 c) believes that it will be necessary to use lime "rather freely where heavy applications of stable manure are made or where green manure crops are plowed under, to prevent possible excessive acidity and fungoid or scab diseases."

A method of soil treatment and enrichment is outlined by W. P. Wright substantially as follows in *Popular Garden Flowers*: In autumn remove the top soil and break up the subsoil, turning in a dressing of three inches of decayed manure. If the ground is very stiff, leaf mold and sand may be added. Leave the surface lumpy. In February, spread on a coat of wood ashes, with an additional quantity of bone flour, at the rate of three ounces per square yard, and fork it in. This operation will simultaneously reduce the lumps to small particles.

H. H. Groff has used the same land for fifteen years, and the only fertilizer he has needed is stable manure and hardwood ashes applied in the autumn before plowing. Hardwood ashes are rich in potash and phosphoric acid as well as in calcium.

B. C. Auten prefers dried blood and steamed bone, with a top-dressing of nitrate of soda and potassium sulfate or muriate. The fertilizer is applied in the seed drill at the bottom of the furrow. Steamed bone and bone meal are to be strongly advocated, since they possess the necessary phosphoric acid and potash.

Luther Burbank has used a complete fertilizer.

G. B. Babcock uses a 4-9-11 Bowker's Market Gardener's Fertilizer at the time of planting.

N. L. Crawford has used an application of five hundred pounds of potassium sulfate per acre at the time of planting, and from three to five hundred pounds more in July or August.

L. M. Gage applies barnyard manure in the fall, and a complete potato fertilizer (4-7-10) in the drills at the time of planting.

J. M. Bassett manures the soil thoroughly either in spring or in fall, and at planting time a commercial fertilizer is scattered along the furrow.

S. E. Spencer places a little sheep manure in the furrow at the time of planting, and works a chemical phosphate into the soil when the buds start.

C. W. Brown has used seven cords of manure per acre in the late fall, plowing it under at once to kill the witch grass.

C. Hoeg distributes hardwood ashes at planting, and nitrate of soda two or three times during the growing season.



W. C. Bull, of Ramsgate, England, uses "stable dung dug in during the winter, and superphosphate of lime at the rate of a double handful per square yard, dusted over the surface of the soil immediately after planting."

Mrs. K. Atkinson applies bone meal two weeks before planting. When the growth is about an inch and a half high, and again when the plants are ready to flower, they are dressed with Bull's Mixture for Plants.

J. L. Moore uses hen manure and stable manure once in three years. Besides this, he sows a cover crop of rye after the bulbs are dug, and plows under the green growth in the spring.

C. Betscher also seeds rye at the time of the last cultivation, the earlier the better. This he would, no doubt, plow under when in greatest growth and full of sap, for the green crop should not be allowed to get woody, thereby losing its greatest value as a humus maker.

W. W. Wilmore, jr., recommends bone meal and sheep manure (one part of bone meal to four parts of sheep manure) at the rate of two tons per acre, using it when the plants are about a half foot tall, thoroughly mixing it with the soil by hoeing and cultivating.

B. H. Tracy suggests the use of bone meal and lime applied in the early spring.

H. A. Richardson applies a good grade potato phosphate at the rate of one thousand pounds per acre, spreading it broadcast after the spring plowing and harrowing it in.

E. T. Barnes prefers well-rotted stable manure, applied either in the fall or in the spring before planting, often after planting and used as a mulch.

C. Zeestraten, besides applying cow manure, has used Chile saltpeter when the flowers are grown for cutting.

M. Crawford uses a complete fertilizer in the grain drill before planting, and believes nitrate of soda a valuable substance if used properly. For small areas he dissolves one ounce of nitrate of soda in ten quarts of water. When using the dry crystals, he distributes it evenly over the surface of the soil at the rate of one pound to a square rod. It is best not to risk applying the fertilizer along the row.

F. C. Thomann has used, besides sheep manure and hardwood ashes, a great deal of soot. It seems impossible to account for the freedom from disease of his Rochester White gladioli in any other way than by the probability that the soot prohibits the spread of the infection.

W. Van Fleet applies a 4-4-8 potato or truck fertilizer broadcast in the row at the rate of six hundred or one thousand pounds per acre, and works it in well before planting. He recommends the avoidance of an excessive use of tankage.

J. F. Munsell uses a 2-8-10 or a 4-6-10 fertilizer placed in the furrow before dropping the corms, or on top of the soil when the corms are partially covered.

Maurice Fuld advises sheep manure only, applied after the plants have made their appearance above ground.

Hamilton (1913) writes as follows: "Those who mix their own fertilizers use the following formula, in many cases varying it somewhat to suit individual needs: nitrate of soda, 100 pounds; sulfate of ammonia, 100 pounds; tankage, 100 pounds; acid phosphate, 100 pounds; sulphate or muriate of potash, 200 pounds."

Coleman (1914 b) writes: "We make our own fertilizer, so do not have to pay freight on 'filler.' A formula that has given us the best of satisfaction and that the Glads respond to, is represented by 50 per cent sulphate of potash, 25 per cent sulphate of ammonia and 25 per cent nitrate of soda, by weight." This is applied sparingly along the top of the row at planting.

Summarizing, it is seen that fertilizers may be applied (a) a year before planting, (b) immediately before planting, (c) in the furrow when half filled, (d) on the surface of the soil at planting, or (e) throughout the season, especially when the buds are developing. It is interesting to note the wide range of chemical fertilizers advocated by the various growers, for each of whom his particular mixture is perhaps the best.

### TIME AND MANNER OF PLANTING

In the Northern States gladiolus corms may be planted in April or May, according to the season, or they may be kept until July if they do not sprout in their place of storage. They should not be planted until the danger of hard frosts is passed, although a slight frost when the shoots are still below the surface of the soil will not injure them. It is necessary to wait until the soil is somewhat dried, especially with clay soil. A corm naturally begins sending out shoots at the approach of spring, so that if the storage conditions are rather warm the corms must be planted before these growing shoots have exhausted their resources. They must be planted so as to allow the shoots to emerge readily from the soil. The shoots often grow around the corm and are difficult to manage, so that the corms need to be planted properly.

When possible a succession of bloom should be planned, the corms being planted in lots every week or ten days until July. In this way an excellent yield of blooms from a favorite variety may be obtained throughout the season.

Corms that are to be grown for rapid increase in size should be planted as early as possible, so that they may have a longer growing period and



make good vegetative growth as well as mature a large corm. Seeds and cormels also need to be planted as early as possible, so that they too may have a long growing season.

Dombrain (1873) describes a method of planting individual corms for the home garden. With a trowel he digs a hole six or seven inches deep and about five inches across, and fills this hole "with a mixture of sand, powdered charcoal, and light soil in about equal proportions, so that the bulb, when it begins to start and throw out its rootlets, has a light and dry material into which to penetrate, and thus is likely to be saved from rotting, and taking care that the top of the bulb is about four inches beneath the surface." This method, although slow and laborious, might be adaptable in the planting of choice seedlings. Usually, however, for small beds the corms may be planted with a dibber, or the bed may be dug out evenly from a depth of from six to eight inches and the corms put in place and covered evenly.

The commonest commercial method is to plant in rows, the corms being placed a little more than their own diameter apart; that is, two-inch corms are placed two and one-half or three inches apart. All bulbs over an inch in diameter are placed right side up; others are merely sown in the row as seed. B. F. White (1911) recommends setting the corms with the eyes lengthwise of the row. Many of the corms send up two or three flower stems, which will not lean over crosswise of the row as they would if the corms were planted promiscuously, for in the way suggested they help to support one another.

In large plantings the rows are frequently three feet apart. This allows for horse cultivation. The furrows are made with the plow. The fertilizer may be applied at the bottom of the furrow, which is leveled with a hand hoe. Two or three rows of corms are frequently placed in each furrow by bulb growers, since they do about as well as if planted otherwise, and, as Gage (1914 b) suggests, "it is surely much more economical to plant 100,000 bulbs on one acre than the same number using two acres or more." When planted in single rows, however, the blooms usually become larger, so that for cut-flower or exhibition purposes this method is the better.

### SPRING AND SUMMER CULTURE

While the gladiolus does not require a great deal of care, it responds to good culture by increase in size of both flower and corm. After the corms are planted it is very essential that the soil be stirred frequently, in order to keep down weeds and to destroy any crust through which the young shoots cannot burst. Weeds are especially difficult to pull in a rather heavy soil after they have attained any size. By cultivation air is permitted to enter to the roots, making more plant-food available.

Shallow cultivation results in a dust mulch, which conserves the moisture by lessening the evaporation from the soil. M. Crawford says that cultivation cannot be overdone; a crop can be cultivated every day, provided the soil is in a favorable condition. It is best not to touch a clay soil when it is too wet. Care should be exercised that the cultivation be shallow. When the corms are not planted deeply, many of the main roots will be near the surface, and hand weeding may be necessary; otherwise the roots are easily injured.



FIG. 13. THE TRIAL GROUNDS OF THE AMERICAN GLADIOLUS SOCIETY

The rows were three feet and six inches apart, and the bulbs were placed nine inches apart in the row.  
Each stake marks a separate variety

Instead of cultivating the gladiolus a mulch of strawy manure may be applied, or some other loose material used to imitate the same conditions as cultivation. This is not believed, however, to be as beneficial as cultivation.

When grown commercially for corms in vast acreages, it is not profitable to use any form of stake for the gladiolus. When cut flowers are wanted, it sometimes becomes necessary to employ a method of support which shall be inexpensive and efficient. Gladioli break at the union of stalk and corm. It is in order to prevent this that stakes are used. L. M. Gage places upright posts five feet apart, with two strands of cheap



twine to which the plants are tied. C. Zeestraten uses stout stakes, with a string around the plants at a height of twelve inches. J. L. Moore prefers a "heavy cord both sides of the row every ten feet, and cross twining." For individual plants slender bamboo stakes are best, the plants being tied to them with raffia or green string.

The value of deep planting in holding the plants erect has already been considered, and it has been stated that close setting of the corms will help to maintain a good, strong, self-supporting row. Many growers throw up the soil on both sides of the row. This is only done after the plants have reached a good height, and it helps to keep the blooming spikes from the mud.

An excellent method for the amateur is described by Rexford (1910). He advocates the use of green-painted barrel hoops, across which coarse binder twine is laced. This support is placed at the height of eighteen inches above the ground. In early growth the shoots can be properly directed into the meshes.

The majority of growers agree that the modern gladiolus should stand alone without support. But many varieties that are excellent in flower, color, and form do not possess a good upright habit. They must therefore be encouraged.

W. W. Wilmore, jr., of Wheat Ridge, Colorado, grows his gladioli under irrigation. This he feels to be necessary, since the early spring rains start the crop into good vigorous growth, which is checked by the heat and drouth of July and August, the only resource left being the nourishment stored up for the next season. This makes weaker corms, which in turn may be expected to produce smaller flower stalks. By the use of irrigation the plants are kept in continual growth. Wilmore (1914 a) describes his system of irrigation as follows:

For irrigation the streams are tapped by canals, which carry water into adjoining sections. The canals are tapped at intervals by sub-canals, and these in turn spread out into laterals which distribute the water directly to the fields or into reservoirs which are generally located on the highest point of the farms in order that the water may have a natural flow to all parts of the premises. It is sometimes necessary to build dikes or flumes to convey the water to these points, and in cases of long distance the water is piped in ordinary sewer pipe which is carefully cemented.

\* \* \* \* \*

At the blooming season cultivation ceases, so well defined ditches may be made to carry water for the balance of the season. At the lower extremities of the rows, waste ditches are made to catch and carry off the surplus water as it passes out at the end of the rows. The waste is conveyed by this means to other plots of land or in some cases to the main lateral where it is again used.

Irrigation water is measured by inches and feet. One inch of water is that amount which will continually flow through a hole one inch square under a five inch water pressure. Ten inches of water is generally allotted to a ten acre tract of land or an approximate number of inches to each acre in a tract of larger or smaller proportions.

In extremely dry seasons irrigation is carried on by means of pumping from wells. These wells vary in size according to the amount of water needed. One of the best



I have seen is on our farm at Wheat Ridge. It is made of boiler iron in four sections, each section being four and one-half feet long and six feet in circumference, making the well eighteen feet deep. At the location of this well the water level is only six feet below the surface which gives a standing body of water twelve feet deep. When pumping, the engine throws a stream of nearly ten inches (irrigation measure) which continues almost two hours as the water runs in nearly as fast as the pump can take it out. Three pumpings can easily be made per day. For convenience wells are much more satisfactory but are more costly to operate.

On the approach of frost the gladioli must be dug up. Many of the varieties will not be very much ripened by that time, so that it is advisable to allow the plants to remain in the soil as long as possible. An ordinary frost is not injurious to the corms, but if left in the ground during a freeze they may be injured. The stock is much easier to handle if the tops are green.

Two methods are used in giving the proper treatment after digging. Some growers cut off the tops about an inch and a half above the corm, while others leave the tops on for a month or two. It is held by the latter that the leaves contain much plant-food, which they continue to deposit in the corms even after these are dug. Cutting off the tops thus produces a more poorly matured corm. Those who remove the tops immediately contend that the leaves, in trying to continue to grow, exhaust the food from the corm, and poor corms are thus produced. It is a difficult question to settle. The writer has tried both methods, and with the comparatively small number handled has preferred to let the tops remain, storing the plants in an airy place until October or November. Then the tops, the old corms, and the cormels are removed, and the whole stock is thoroughly cleaned for winter storage. For small lots, ten-pound sacks left open at the top have been used.

If the weather is favorable, it is well to allow the stock to lie on the ground to dry a little before taking it indoors. The heavy dews of autumn, however, may make the stock more moist if it is allowed to remain out over night than it would be if taken directly under shelter. A great deal of the soil can be easily shaken from the corms in the field, especially if the soil is sandy or loamy.

### THE GLADIOLUS BLOOM

The gladiolus bloom consists of six perianth segments fused at their bases. There are an outer and an inner row, the outer row being considered as sepals, the inner as petals; collectively they form the perianth.<sup>2</sup> The flower may be divided also into upper and lower segments.

The perianth segments are variously arranged. The most frequent arrangement is that in which the uppermost segment is without, overlapping the adjoining segments, the lowermost is within, embraced by

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<sup>2</sup> The horticulturist often applies the term *petal* to any segment of the perianth.

the contiguous segments, and the upper pair of laterals are overlapped by the lower pair of laterals. The segments may have a directly opposite arrangement, in which the upper segment of the perianth is within. This arrangement of the various segments has been called *anthotaxy* by Jackson (1889), who styles the differences in arrangement A and B. The term should be *æstivation*, and the various arrangements designated as one-, two-, and three-spotted æstivation. Jackson says:

A single spike may be composed of flowers of the first arrangement (A) wholly, or it may have flowers of both arrangements in varying numerical proportions; but the first (A) as far as noted always predominates. Flowers of the second arrangement (B) may be the first, last, or scatteringly intermediate on the spike. The two arrangements are fundamental in the flower, they are not brought about by twists in the segments. The arrangement of the cell in the ovary coincides with the varying relative position of the segments.

In *Gladiolus dracocephalus* and *G. purpureo-auratus*, the arrangement is of the second type. *G. psittacinus* is the only species noted in which there was a variation in arrangement. In this species most of the flowers are as in the first arrangement, but a few follow the second type of æstivation. Jackson states that the existence of two types of perianth arrangement on a single spike in a true species would be

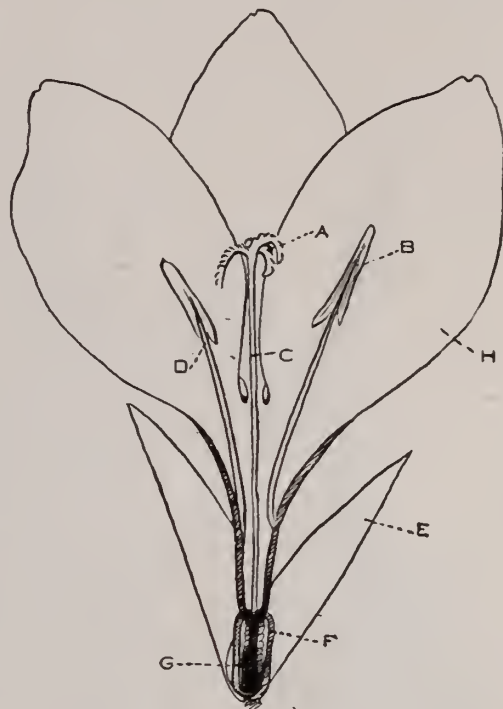


FIG. 14. LONGITUDINAL SECTION OF GLADIOLUS BLOOM

The outer part of the flower is made up of perianth segments (H), commonly called petals, to which are attached the stamens, which are made up of anthers (B) and filaments (D). At the center of the flower is the pistil with its feathery, three-lobed stigma (A), the long thread-like style (C), and the ovary, or ovulatory (F), which bears the ovules, or potential seeds (G). The base of the flower is surrounded by two leaf-like spathe-valves (E)



FIG. 15. ÆSTIVATION IN GLADIOLUS

A, two-lipped, the upper inner segment is a trifle arched. B, one-lipped, the outer segments are frequently somewhat reflexed

of the other type being due to other species. He thinks this suggestion is borne out by the hybrids of *G. purpureo-auratus*, for

anomalous, and its occurrence in hybrid gladioli should be considered as the inheritance of a mixed blood, the occurrence of the one-spotted lip being due to one type or species, and the inheritance



both arrangements are found in hybrids although the two-lip is characteristic.

J. G. Baker suggests terming the various lip markings as *monospite* when one-spotted and *dispite* when two-spotted.

It is quite possible that by studying this character one might find out the original parentage of many of the garden hybrids. Perhaps closer relations could be found between certain species by this means.

Bliss (1916) considers that there are four types of gladiolus bloom, as follows:

1. The zygomorphic, or normal, form
2. The reversion form
3. The actinomorphic form
4. The semi-peloriolate, or florist, form

He believes these forms to have appeared due to variations caused by exceptional or changed culture, rather than by genetic origination. In other words, they are not the results of the influence of the parent species. He differentiates the various forms as follows:

The normal flower is zygomorphic, or bilaterally symmetrical. All the flowers face in one direction and rather horizontally. The three outer segments of the perianth are about equal in size and are larger than the inner segments. The inner segments are unequal in size and vary in form and color. The upper segment is usually considerably hooded, while the lower segments are convex and have markings characteristic of the variety. The zygomorphic flowers seem ideal in form and color for attraction of insects. It is thought that they have been developed from a more primitive form—the actinomorphic, radiating, or regular form.

In the reversion form the outer segments are similar in shape and color. The inner segments also are similar, and all three have markings characteristic of the variety. The flowers of the acti-

nomorphic and reversion forms are erect and face in two directions, while the normal, or zygomorphic, form and the florist form are front-facing.

The florist form seems intermediate between the zygomorphic and actinomorphic forms, but it is still zygomorphic. In the florist form the

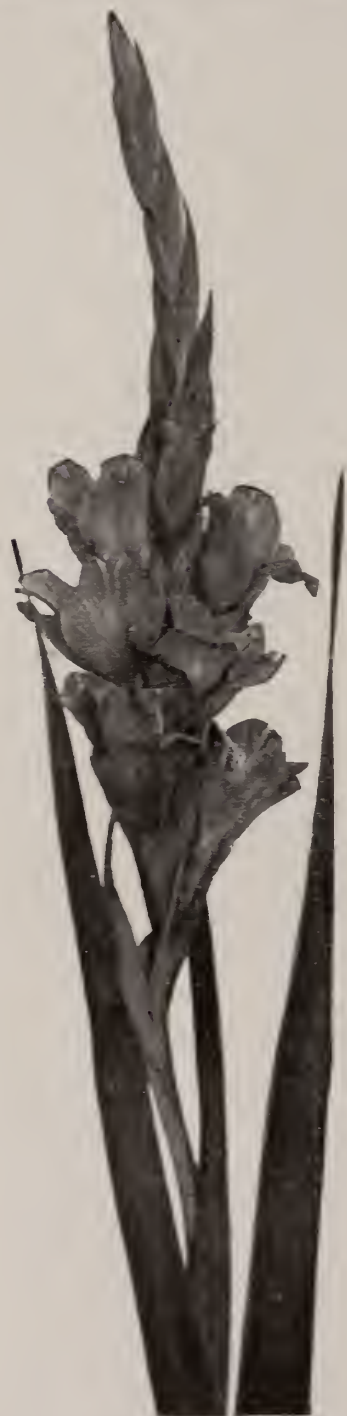


FIG. 16. EUREKA

This variety illustrates the peculiar upright, lily-like blooms

flowers are partly horizontal-facing, and are more erect than in the normal and less so than in the actinomorphic form. At the same time the flower often varies a little, in that one segment only is blotched. Flowers that are naturally irregular but become regular through a symmetrical repetition of the irregularity, are known as *peloric*, or *peloriate*. The florist form is thus semi-peloric.

Careful observation will determine whether this is a fair explanation of the forms. Varieties differ much in their arrangement of the various forms of flowers found on a single spike. According to Bliss (1916), there are fewer florist type flowers "when young, or crowded, or in poor soil, and more when at full size and under most favourable conditions. . . . If the stem of a variety which usually produces all or many semi-peloriate flowers is partly cut through and bent over, the flowers, when they open, will be chiefly, if not all, of the normal form—and some even of the reversion form."

Among the varieties on the trial grounds at Cornell University, Eureka and Chalice seem excellent examples of the reversion form. In both cases the flowers are lily-like and erect. The variety Dandy produces many flowers of the actinomorphic form. Bird of Paradise follows rather closely the arrangement of *Gladiolus oppositiflorus*.



FIG. 17. BIRD OF PARADISE

This variety illustrates the extreme *Gladiolus oppositiflorus* characters in the arrangement and large number of its flowers



It would seem that this variation in form of flower is due to hybridity, or the mingling and blending of forms from various species, rather than to the external influence of ecological factors. The angular bloom of the typical *Gladiolus gandavensis* crossed with the more bell-shaped bloom of *G. purpureo-auratus* would seem to offer a possibility of getting the semi-peloriolate form, which would be intermediate and should face nearly front, due to its parents *G. psittacinus* and *G. purpureo-auratus*, though often tending toward the decidedly opposite or two-direction facing of the parent *G. oppositiflorus*. *G. cruentus* and *G. oppositiflorus* seem to have been potent influences in eliminating the hooded character, or, in other words, to have caused a greater symmetry, or actinomorphy. It must be admitted, however, that neither solution explains the mixed arrangement of forms on a single spike.

### IDEALS IN FLOWER AND IN GROWTH

The ideal form for the gladiolus bloom may now be considered. In most cases the bloom should be nearly round in outline, the upper segments broader than the three lower ones, the central segment slightly arched but not enough to be really hooded. Usually the segments should be as broad as long. The three lower segments, according to some ideals, should be equal in size and symmetrical; the lip segment or segments should not be narrow or pointed, nor smaller than the others. It must be remembered that the species *Gladiolus primulinus* is hooded and seems to transmit this quality to its seedlings. These should not be condemned for this, however, but admired. Certain other varieties, though much admired, are faulty in having extremely small and narrow lower segments.

The gladiolus is remarkable for its range of color, which varies from the most brilliant scarlet to pure white, from bright rose to clear yellow, gorgeous purple, and rich velvety maroon, beside all the intermediate shades, tints, and colors in endless combinations, together with the most unique markings. These markings are described as dots, stippling (very fine dots), splashes (long, irregular patches of color, or dashes), feathering (fine markings originating at the outer edges of the segments), mottling (irregular spots), blotches (regular, large areas of color found on the lower segments in *Lemoinei* varieties and other groups), penciling (fine lines in the throat, found especially in *gandavensis* and *Childsii* varieties), suffusion (colors laid on as though painted over another color), marbling (intermixed or clouded effects), blends (gradual transitions of one tone to another), and flecking (small dashes). Each of the wild species has contributed to this motley array of beauty. Where is there a flower with such a range of diverse markings?



For commercial use, the general consensus of opinion is that the bloom should be white, pink, scarlet, yellow, or red, or perhaps blue. Maurice Fuld objects to blue in that it does not appear to good advantage in

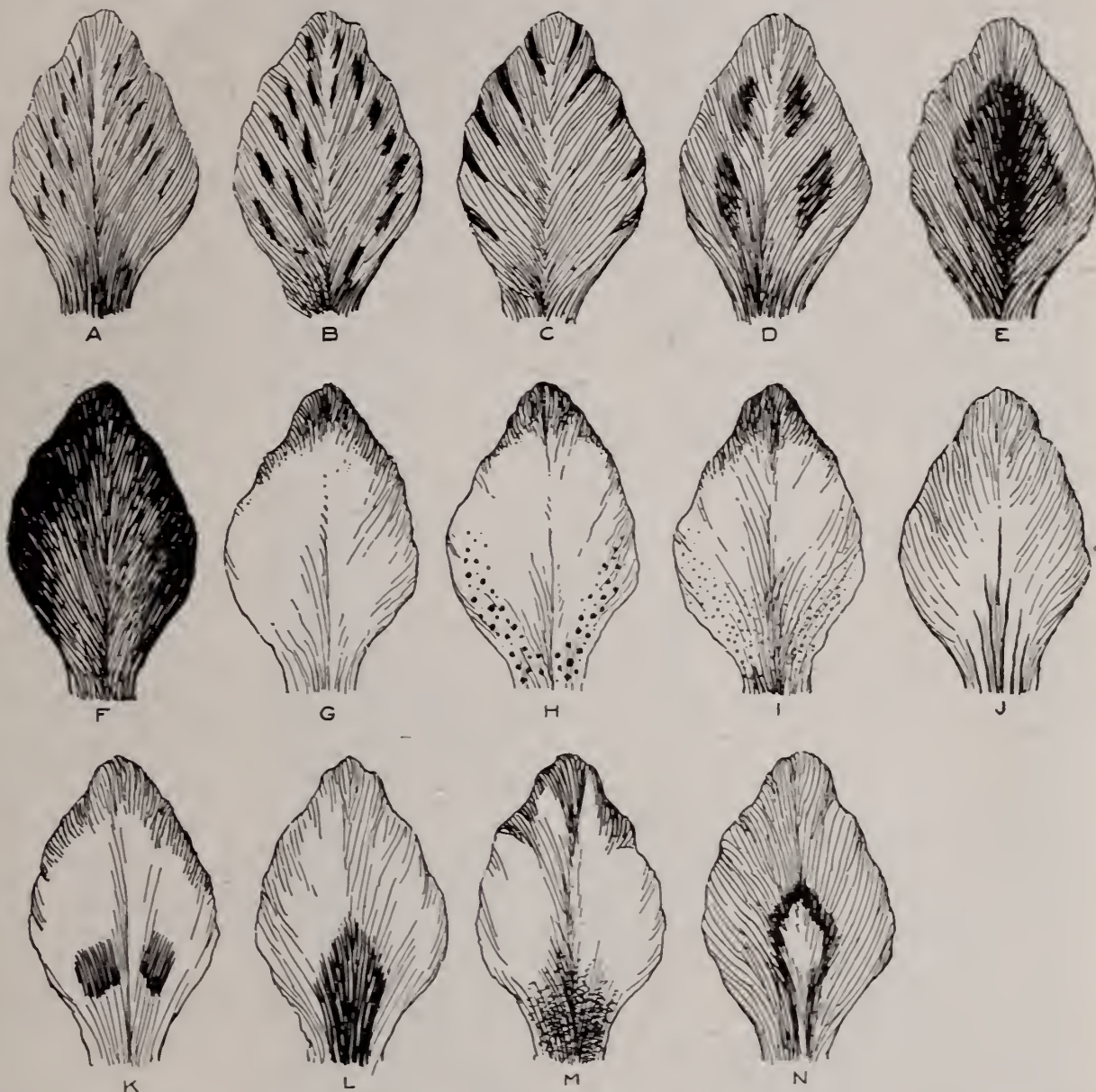


FIG. 18. MARKINGS FOUND IN PERIANTH SEGMENTS OF VARIETIES OF THE GLADIOLUS

A, flecks (very small dashes); B, dashes or splashes (long irregular dashes); C, feathering (dashes or fine markings that originate at the outer edges of the segments); D, mottling (irregular spots wider and more prominent than dashes); E, suffusion (colors laid on as though painted on another color); F, blend (gradual transition from one tone of a color to another of the same color, or from one color to some other different color); G, clear throat (unmarked in any way); H, dots; I, stippling (very fine dots in the throat); J, penciling (lines of the throat); K, mottling (irregular spots in the throat); L, blotch (regular, large areas of color, on lower segments); M, marbling (an intermixed or clouded effect); N, the lozenge blotch found in many of the *nanus* varieties in which the center is clear and the outer edge much deeper in color.

A, B, C, D, E, F, and G are found in various parts of the perianth. H, I, J, K, L, M, and N are throat markings

artificial light. Matthew Crawford writes: "The color should be choice, high-priced, more like carmine than vermillion. Colors may be tinted, but should not appear bleached, washed out or faded." B. C. Auten emphasizes the importance of having the colors lively, rather than dull.



FIG. 19. LA LUNA

This is an excellent white variety attractively blotched on the lower segments with maroon. For straightness of spike, regularity of form, and clearness of the glistening white color, few varieties excel this one

F. C. Thomann's ideal is a color that does not fade when the flowers are cut. Most growers agree that clear, decided colors are the best, and the nearer the concolor type the better; G. B. Babcock and G. D. Black say that the blotch is very often objectionable. Florists demand a light-colored bloom, usually because it can be used for a greater variety of purposes; but there seems to be a difference of opinion as to this. E. T. Flanagan says that the darker colors are in demand only when the lighter ones are scarce. J. F. Munsell uses more than one-half red varieties, and H. A. Richardson finds only from fifteen to twenty per cent as great a demand for the darker colors as for the light. Several growers agree that



the darker colors are especially valuable for decorations when quantities of color are needed. Mrs. K. Atkinson, secretary of the National Gladiolus Society of England, writes that scarlet is one of the best selling varieties in England. Dombrain (1873) states that when colors are not clear they should be without splashing, and E. T. Flanagan adds that the variegated blooms are not to be so widely admired. M. Crawford sums



FIG. 20. DIVERSE MARKINGS OF VARIETIES

A. Estella  
B. Herold  
C. Paul Böhme  
D. Winsome  
E. Wilhelm Steinhausen  
F. Stewart No. 573

G. Minnesota  
H. Tavistock  
I. Hazel Harvey  
J. Sanguine  
K. Marie Lemoine

L. Papillon  
M. Sultane  
N. Nezinscott  
O. Halley  
P. Hofgärtener Stapf

These segments are reduced to approximately one-half natural size

up the color question by saying that fine coloring is the one requirement, without which all other perfections go for naught.

In considering the value of colors for landscape use, B. F. White considers all colors admissible so long as they are bright and brilliant. Burbank prefers the solid colors. Mrs. A. H. Austin and Mrs. K. Atkinson, and Messrs. Van Fleet, Macomber, Burbank, Bassett, Black, Spencer,

Brown, Hoeg, Tracy, Wilmore, Richardson, and Moore, agree that bright, brilliant, and distinct colors are demanded for a landscape variety.

As to size, most growers prefer a medium large bloom — one large enough to show the color well. Perhaps the bloom of the variety America is large enough. However, the craving for monstrous flowers is manifested among the gladiolus enthusiasts. Large blooms are especially admirable when associated with long spikes and extreme vigor in growth.

The general opinion is that the blooms should be as wide open as possible. However, W. C. Bull, of Ramsgate, England, prefers a bloom not too open, though the tips of the petals may recurve somewhat.

The substance of a bloom should be tough, thick, and leathery, not brittle, but firm and not easily damaged. For landscape purposes the blooms need to be "atmospheric in outline," as H. A. Richardson expresses it. Keeping quality is associated with substance, and is of prime importance in the consideration of either landscape or commercial cut-flower varieties.

The spike should be long enough to allow cutting of the bloom ten inches below the lower flowers. C. W. Brown says, "The stem should be only strong or stiff enough to hold up all buds till they open." A stem that is rather thin and wiry, rather than thick and stiff, is to be preferred; but it must be strong. One of the greatest advances to be made is in just such an ideal stem. C. Betscher and M. Crawford emphasize the fact that the stem must be large enough to take up sufficient water. This defect is present in some *Lemoinei* varieties.

The question as to the number of blooms that should be open at one time is a perplexing one. A great mass of bloom out at once may be desired, or one may prefer to have a few flowers only, so that the spike may bloom for a longer period. Van Fleet says "three or four"; Fuld, "as many as possible"; N. L. Crawford, "two each day"; Gage, "several, and if large, three or four"; Moore and Huntington, and Mrs. Atkinson, "many." In the landscape varieties, Fuld, Burbank, and Moore consider that it is better to have a large number open at once; and Moore adds that the blossoms should remain open for some time before they wilt. N. L. Crawford considers that from six to eight should be the right number.

The old *Gladiolus oppositiflorus* (fig. 17) type of inflorescence has now passed out, and it is desired that the blooms shall face in one direction only. W. W. Wilmore, jr., and Mrs. Atkinson, consider that the flowers should be closely set on the spike, while many others prefer the looser arrangement.

A subject of further controversy is the matter of branches and their value to either a commercial or a landscape variety. Hoeg, Babcock, Betscher, White, Thomann, Wilmore, Bonvallet, and Hutchinson consider





PHOTOGRAPH LENT BY MRS. B. H. TRACY

FIG. 21. NIAGARA

This is one of the finest creamy white varieties, for it is beautiful in all stages of bud and bloom. The lower segments of the flower are faintly penciled with lavender. This variety makes a very strong growth

branches of value in the garden varieties in that they indicate stronger growers. Burbank remarks that they improve the appearance of "the dwarf, sturdy varieties"; Auten believes them of value because they heighten the effect "when they bloom at the same time as the main," and Betscher because they may "extend the season." Bonvallet values branches chiefly because they relieve the stiffness of the plant. Brown, Spencer, Bassett, N. L. Crawford, Stewart, Flanagan, Van Fleet, M. Crawford, Zeestraten, Moore, Bull, Tait, and Mrs. Atkinson are of much the same opinion — that branches are of a decided advantage for cut-flower use. Branches may, however, be considered of value to the florist who uses the individual flowers in design work. On the other side, there is a group of growers who believe that branches are objectionable; some



FIG. 22. TRANSFORMATION OF A STAMEN INTO AN EXTRA PERIANTH SEGMENT, OR PETAL

A is a normal stamen, which in B shows a tendency of the filament to widen. C, D, E, F show successive stages of the transformation of the filament, in each step of which the anther area is plainly visible. G is a stamen fully converted into a perianth segment in which the blotch represents the anther area. These forms were found on one spike of a seedling

of these believe that the branches reduce the vigor of the main, and others hold that branched spikes are difficult to pack properly.

Fuld notes that commercial varieties should be those that may be cut when only one blossom is open, with the ability to open the others in the dark. A requisite of a commercial variety is also that it may be packed without bruising and shipped easily without injury.

The qualities of a good variety adapted to landscape planting are as follows: First of all, the color should be bright, striking, and distinct; the markings, if any, should be decided. The spike should be straight, stiff, upright, and stronger than in commercial varieties. Branches are rather advantageous. There should be tall, medium, and dwarf varieties, so that few varieties would be objectionable for this reason. The blooms should be larger than in the commercial varieties, provided the plants have the power of producing flowers of uniform size all the way up the



stem; they should be of good form, well open; the growth should be erect and remain so; and the plant should be compact in habit, due to heavy foliage. Varieties adapted to landscape planting should further be of such constitution that they stand the sun without fading.

There is a great difference of opinion in regard to the value of curved spikes. Fuld, Macomber, Van Fleet, Betscher, Richardson, Fischer, Zeestraten, Tait, Wilmore, Brown, Spencer, Stewart, Auten, and Burbank commend them, believing them to be more graceful and artistic than the



FIG. 23. DOUBLE FLOWER OF KLONDYKE

This flower has six stamens, two pistils, and twelve perianth segments

straight. Tait limits their value to the varieties bearing small flowers. Auten thinks them valuable for funeral sprays. Many growers consider them good for vases. It is the common complaint, however, that the florists do not want them.

Would doubling be an improvement, was the question asked of two hundred gladiolus enthusiasts. The answers were varied. Bull thinks the idea "too horrible to contemplate." Richardson writes thus: "Simplicity rather than complexity is one of the most desirable characteristics to be sought for. The simple spacing arrangement and abandon

of the single flowers on the spike of such varieties as Peace and Rosella, add greatly to their artistic value." Hutchinson, Zeestraten, Tracy, Krelage, Tait, Barnes, Fischer, Van Fleet, Betscher, M. Crawford, Wilmore, White, Hoeg, Babcock, Black, Macomber, Gage, Huntington, Munsell, Fuld, Flanagan, and Mrs. Austin believe that doubling would not be an improvement. Bonvallet argues that doubling would make the flowers more durable. Spencer says: "Any new feature would add greatly to the popularity of the flower, as did the cactus dahlia." Thomann thinks a semi-double variety might be an improvement. Auten believes that it depends on what form the flower takes in doubling.

The following card has been devised for use in describing varieties of gladioli on the trial grounds of the American Gladiolus Society at the Cornell University Agricultural Experiment Station:<sup>3</sup>

### CORNELL VARIETY TEST OF GLADIOLI

No. ....

NAME ..... OLD NOS. ....

SYNONYMS .....

ORIGINATOR ..... DATE INTRO. .... DONATED BY .....

SPECIES ..... OBSERVER ..... DATE .....

**BLOOM** — SIZE — Very large-large-medium-small.

COLOR ..... marking }  
 SEGMENTS — Equal-unequal; connivent-separate.

UPPER — Horizontal-hooded-reflexed; broad-narrow. LOWER — straight-reflex; broad-narrow.

STAMENS — Color of filament; ..... of style; .....

TUBE — Straight-curved; slender-stout; long-short; compact-loose.

**SPIKE** — Tall-medium-short; erect-curved-drooping; free-fair-bloomer-no bloom. No. blooms .....  
 Branched? .....

**REMARKS ON BLOOM** — Compact, loose; keeping quality .....; substance .....

**HABIT OF PLANT** — Erect-drooping; tall-medium-dwarf. Height of plant .....  
 Spreading-compact.

**GROWTH** — Good-medium-poor. **SEASON** — Early-mid-season-late.

**PROLIFICACY** — No. CORMS — Many-few. **SIZE** — Large-small. No. CORMELS — Many-few. **SIZE** — Large-small.

**FOLIAGE** — Well-furnished-medium-poor; broad-medium-narrow; veins prominent-obscure.

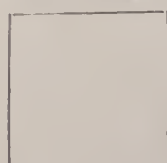
**COMMERCIAL VALUE** — CUT FLOWER — Extra good-good-medium-poor.

LANDSCAPE — Extra good-good-medium-poor.

**VALUE AS A WHOLE** — Extra good-good-medium-poor.

**REMARKS:**

ÆSTIVATION



No. corms sent ..... No. that grew ..... No. bloomed .....

<sup>3</sup> The introductory paragraphs of Cornell Extension Bulletin 11, *Gladiolus Studies — III. Varieties of the Garden Gladiolus*, explain the methods used in describing varieties.



It will be interesting to note the score card devised by the Gladiolus Society of Ohio.

#### SCORE CARD, OHIO GLADIOLUS SOCIETY

The ideal, or perfect Gladiolus combining all the qualities here enumerated, should score 100 points. Approximation to the ideal standard, which is all that can be looked for at this time, should be designated by the award of points ranging from 0 to the full total in each case, according to the excellences of the specimen under consideration.

1. SPIKE — 20 Points.	
Long, 5; Straight, 5; Many blooms, 5; Facing together, 5.....	20
2. FLOWER — 25 Points.	
Large, 5; Widely opened, 5; Broad, round petals, 5; Substance and texture, 5; Beauty of bud, 5.....	25
3. COLOR — 20 Points.	
Attractive, 10; Either clear self, or strikingly marked, 5; Adapted to cut flower trade or florists' use, 5.....	20
4. FOLIAGE — 15 Points.	
Dark, healthy green, 5; Broad, 5; Abundant, 5.....	15
5. DURABILITY — 10 Points.	
Continuance of bloom on spike, 5; Lasting qualities as cut flower, 5.....	10
6. GENERAL EFFECT — 10 Points.	
In mass, bed or field, 5; In vase or cut display, 5.....	10
	<hr/>
	100
	<hr/>

At the annual meeting of the American Gladiolus Society at Baltimore in 1911, a scale of points was adopted to be used in conferring an Award of Merit. Mrs. Frank Pendleton is the only variety that has been examined according to this standard and has received the Award of Merit.

#### AMERICAN GLADIOLUS SOCIETY SCALE OF POINTS FOR CONFERRING AWARD OF MERIT

Resistance to disease.....	5
Texture of bloom.....	10
Duration of bloom.....	10
Size of bloom.....	10
Color of bloom.....	15
Form of bloom.....	10
Form of spike.....	10
Stem, length and stiffness.....	10
Number of blooms on spike.....	15
Vigor (aside from disease resistance).....	5
	<hr/>
	100
	<hr/>

In the enumeration of ideals, adaptability to a great range of soil, disease resistance, blooming entirely around the stem, variegations of the leaves, fragrance, greater value for indoor culture, hardiness, keeping qualities, number of blooms on the spike, and color of the stem, have been omitted. Certain of these ideals are at present fulfilled, others will be attained, and some are not worth seeking.

Groff (1907 a) said: "If the breeder uses his full opportunity, this ideal will be a progressive quality, and his standard will advance yearly as he sees the results attained by unlocking the treasures of ages of the past in scientific, though unrecorded, practical plant-breeding."



FIG. 24. MRS. FRANK PENDLETON

One of the superb pink varieties. The lower segments are gorgeously blotched with French purple. The growth is strong, and the flowers abundant

material advantage; consequently he must take the risk of growing a stock of his new plant on the ground of his personal conviction that it will be profitable, and then, if he can, he must sell this stock of plants to the public at paying prices. How difficult is his task of making a large amount of money out of a single new plant hybrid becomes apparent when we consider how easily any one can obtain a few seeds or cuttings by dishonest methods, from these produce the identical plant, and in a few years have a stock of plants of the same kind for sale, and even claim to have himself originated it by crossing. Coupled with this difficulty, which seems to be inherent in the creation of plant hybrids, is a still greater one, that of adequately testing the new variety before putting it on the market. One can therefore see the reason, or at least one of the reasons, why even more has not been done to make new forms of plants which combine old characters or bring into expression new ones.

## HYBRIDS AND HYBRIDIZATION

### GENERAL DISCUSSION

The first record of the crossing of plants was in 1719, when Thomas Fairchild, an English gardener, crossed a carnation (*Dianthus caryophyllus*) with sweet william (*Dianthus barbatus*). David Fairchild (1912) writes:

This seems a long time [referring to the two centuries since the first hybrid was made] if measured in the terms of mechanical invention, but when it is remembered that with most plants such a cross as that first one produced can be made only once a year, the accomplishments of plant hybridization appear truly remarkable. A mechanic makes a new machine and tests it at once; a plant breeder makes a new cross, but must wait for the following season, and if his plant is a tree or shrub he must wait for many seasons before he knows whether he has obtained from his cross something worthless or a new hybrid which is an improvement over that which the world already has.

The inventor makes his machine, patents it, or keeps some feature of its manufacture secret, and on the basis of his secret or his patent convinces capital that some kind of a monopoly can be maintained by which the exploitation of the invention can be made profitable. The plant breeder, on the other hand, can not patent his new variety, neither can he keep its origin secret to any



Perhaps few words have been so universally discussed as the term *hybrid*. Many definitions state that a hybrid is the result of the crossing of two species. Since Mendelism has gained prominence, a hybrid is defined as the offspring of crosses between individuals of a distinctly different nature. The word *cross* is now used interchangeably with the term *hybrid*.

A sport, or mutation, is a sudden departure from the type of the race, and is capable of breeding true to seed. It is to be remembered, in considering so complex a hybrid as the garden gladiolus, that all sorts of unusual forms appear from time to time, which are not mutations but are hybrid forms that would logically be expected from such crosses. New forms that arise from seed should not be considered sports; a careful study of the constitution of the parents will determine their character. It is possible that forms such as *Colvillei albus* can be considered mutations, but perhaps they are merely recessive forms in hybridization.

Stewart (1914) illustrates and describes a gladiolus sport from the variety Black Beauty which has the normal red flowers on one side of



FIG. 25. MRS. MONTAGUE CHAMBERLAIN  
This white bloom is most daintily penciled. The openness of the bloom adds to its attractiveness

the spike and several white flowers, resembling La Luna, on the other



FIG. 26. CHICAGO WHITE

This is one of A. E. Kunderd's varieties. It is exceptional in having a long spike of white blooms penciled with Tyrian rose. A good commercial variety and very attractive as a cut flower, being of good substance and attractive color, and having many blooms open at one time



side. This is known as a bud sport, and, being localized, would not be expected to be propagated (fig. 27).

Except for examples of this sort mutations would be very difficult to recognize, since in order to be propagated a sport must originate in the corms or the cormels, in which case it might easily be taken as being due to a mixture in the corms. The greatest care is necessary to keep varieties from getting mixed either by allowing a few corms or cormels to remain in the soil or by their becoming mixed in storage.

The fact that some white varieties become heavily feathered with pink is not attributed to sporting and should not be so considered. This condition is due to an environmental influence and is not permanent.

There are a few fundamentals that seem essential for intelligent breeding to-day. Breeding that is haphazard may produce results, but if properly directed thought is given, the work will be crowned with greater success. The practical breeder and the scientific man both deal with the same materials, but in vastly different ways. The practical breeder is concerned with the maintenance and improvement of his crop. The student of heredity is interested in how the characters

are transmitted. He often places the idea of improvement in the background, preferring to study the factors related to his problem; while the practical breeder is not concerned in the interpretation of the results, but centers his attention on the ultimate attainment of an ideal.<sup>4</sup>

Although men have bred plants for years, it was not until 1900 that a scientific explanation was offered for the behavior of plants in crosses.



FIG. 27. BUD SPORT OF BLACK BEAUTY

E. E. Stewart found among the stock of Black Beauty, a deep crimson variety, one spike which produced four or five blooms much resembling La Luna. This is a remarkable case of a bud sport. The blotch on the lower segments differs widely from the more or less intermixed throat markings of Black Beauty

<sup>4</sup> These ideas are inspired from reading the introductory words from *Breeding and the Mendelian Discovery*, by Darbishire (1911).

In that year a very important paper by Gregor Mendel, the Abbot of Brunn, was discovered. Although the paper was published in 1865, the facts were not known nor appreciated during the intervening thirty-five years. Previous to the knowledge of this publication, generalizations only were made as to the result of crosses. Breeders noted that in many cases the offspring was rather intermediate in the first generation, and that later crossings gave some plants like the original parents but mostly of a very heterogeneous nature. Unlike his predecessors, Mendel did not consider plants as a whole, but studied individual characteristics. He illustrated by experiments with the garden pea that there are law and mathematical proportions in the results to be obtained. He first found that crosses between tall varieties and dwarf varieties gave tall forms, but that on propagating from these the tall forms broke up so that seventy-five per cent of the offspring were tall and twenty-five per cent were dwarf. Of the seventy-five per cent tall forms, one-third were pure; the remaining two-thirds were impure and apparently of the same constitution as their hybrid parents. The dwarf forms continued to breed true. Two facts were brought out in this experiment. The first is dominance, or the complete resemblance of the first generation to one parent, the characteristics of the other parent being entirely masked; the second is segregation, or the separating in the second generation into definite proportions of the characters concerned in the cross. Obviously all cases are not so simple.

As stated by the writer in a previous article (Hottes, 1915 a), the gladiolus offers an excellent example of a genus of plants that has been improved for garden purposes by the incorporation of a number of species into more complex multiple hybrids than in the case of most garden flowers. The china aster (*Callistephus hortensis*), the sweet pea (*Lathyrus odoratus*), the peony (*Paeonia albiflora*), and the Boston fern (*Nephrolepis exaltata* var. *bostoniensis*) have been improved solely by the selection of variations and mutations within a single species. Phlox, German iris, larkspur (*Delphinium*), dahlia, columbine (*Aquilegia*), begonia, and chrysanthemum varieties have arisen from the hybridization of several species. The rose, the orchid, the pelargonium, and the gladiolus, however, often have in the make-up of their best varieties from three to seven species, each contributing characteristics to the modern degree of perfection.

It is thus seen that every gladiolus variety dealt with is at the start a multiple hybrid. The variety Princeps is at least a fifth-generation hybrid in which are resident the characters from at least six species.



The wild species have in most cases come to be looked upon as "pure types," that is, plants that when self-fertilized will produce the parental characters identically. In hybridization these types are crossed, and, as before mentioned, the result is a new type bearing the characters of both parents, the characters of the weaker, or recessive, being at first masked by the predominating influence of the stronger. It is this type that is often preferred, and when it is self-fertilized the result is a mixture of seedlings, of which some are identical with one of the two parents and others possess the parental characters in combination. It is therefore advantageous that the gladiolus propagates vegetatively, for only in this way could a pure strain of the first-generation hybrid be preserved or any other subsequent forms be obtained.

Jackson (1889) published an account of hybrids made between *Gladiolus purpureo-auratus* and *G. gandavensis*, and it is truly remarkable to see how close his results are to true Mendelian proportions. It must be remembered that it is very doubtful whether Jackson had ever seen Mendel's paper, which was not widely known until 1900. To appreciate his results the parents may best be briefly described.

In *G. purpureo-auratus* the flower is deep, bell-shaped, and tubular. The two lower petals are marked with broad, elongate blotches of maroon-crimson. At the base of the blotch near the center of the flower, the color heightens to a deep, rich crimson over a very small area. This rich coloring is an important factor in the result obtained in the colors of hybrids, in which the whole blotch is commonly a rich crimson. On the margin of the blotches is a lip-like splash of golden yellow. The color of the remainder of the flower is pale yellowish green. The plant has foliage narrower than that of the *gandavensis* varieties. The spikes are graceful and subarcuate, or bow-like. The flowers are rather far apart, all facing one way; and in view of the arcuation of the flower stalks, and the pendant bell-shape of the flowers, their interior is not easily seen.

Van Houtte, in his catalog for 1841, the year of its introduction, describes *G. gandavensis* as follows: "Its dimensions surpass *ramosus*; its majestic flowers, to the number of eighteen or twenty, are of a most charming vermilion, their inferior petals adorned with chrome, amaranth, and brown, are relieved by anthers of an azure blue which descend to the center of the flower."<sup>5</sup> The lower petals are usually penciled by lines of amethyst or maroon, this being one of the most prominent characteristics of the variety.

<sup>5</sup> Translation from the original French.

The results of Jackson's crosses are here noted, without the knowledge whether these hybrids are the results of selfed individuals. The results approximate a second-generation 1:2:1 ratio in the inheritance of markings.

#### Inheritance of markings

Theoretical  
amount that  
should have  
obtained  
(per cent)

#### Actual result

25	26 per cent marked on lower segments with <i>purpureo-auratus</i> blotch; in many cases not maroon-crimson but a rich crimson. (A color found at the base of the blotch in the parent species.)
50	53 per cent possessed a combination of the linear stripe of <i>gandavensis</i> and a blotch-like stripe of <i>purpureo-auratus</i> .
25	18 per cent had <i>gandavensis</i> penciling.

The occurrence of a white patch in the petalage seems to be the effect of an inheritance of the pattern. The yellow splash at the margin of the maroon blotch is often wanting, but usually inherited, showing that this yellow splash and maroon blotch are not inseparable, but are transmitted independently.

In the case of the other characters noted, which may be due to multiple factors, the results are not of the simple 1:2:1 ratio, but are of interest to note:

#### Inheritance of shape of bloom

80 per cent, form sub-open or flaring; an intermediate between the two parents. Some were as widely flaring as the magnolia. This proportion may be a little large since the shape is difficult to determine.

8 per cent were of the bell-shaped bloom of the *purpureo-auratus*.

#### Inheritance of foliage and habit of plant

90 per cent of cases intermediate.

10 per cent, tendency toward the greater size and increased rigidity of foliage; a character of the *gandavensis*.

#### Inheritance of stoloniferous habit

Generally inherited. Contributed by *purpureo-auratus*.

#### Inheritance of æstivation

This character concerns the arrangement of segments of perianth which are, in most species, disposed so that there are two inner lower petals; but often there is but one.

Most of the flowers show the two-lipped type of æstivation; at least 75 per cent should have done so, for the species *purpureo-auratus* is characteristically so and the species *psittacinus*, a parent of *gandavensis*, possesses both forms. The one-lipped æstivation occurred only as scattering individuals upon a spike.

Fischer (1914) writes:

I see no reason why we should not benefit by the use of the Mendelian method in the practical side of gladiolus breeding; that is in the creation of new types by the recombination of pre-existing characters. To begin, one must have an ideal form or



variety in mind, and then choose parents having characters, that being combined, should tend to produce this ideal result. These parents are then crossed. . . .

The cross-bred seeds thus produced are sown. . . .

. . . These hybrids must be self-fertilized, and it is important to lay stress on the necessity of sowing a large amount of seed from which your family of the second generation is to be grown. There must be enough to give a chance for the combination of your desired qualities, and the possibility of other rarer combinations to appear in order to obtain novelties.

Fischer has noted dominance and the recombination of preexisting characters. For example, "in crossing a large red flower with a small white one, the offspring all came in different shades of red in the first generation, and all were large sized flowers; in the second generation the majority again came red, but a few came light colored and white with large sized flowers."

Growers have noted that the colors in certain varieties change, due to an external influence of various heat, moisture, or soil conditions. It is known that when the hydrangea flower is given a treatment of iron it becomes a clear blue; and the red flower of *Primula sinensis* var. *rubra*, when grown in a temperature of from 15° to 20° C., yields white flowers, while it will again produce its red flowers under normal conditions. Obviously, the variety *alba*, which has white flowers, produces them at any temperature. When a transplanted variety is again grown in its original locality, the old characters should return. Growers who have contended that there are various types of certain varieties due to the locality in which they are grown, can easily determine whether or not these varieties are identical by growing all of them on trial grounds for several years and observing whether they resume their normal or identical appearance. If not, the varieties are different.

It must not be forgotten that, as J. A. S. Watson (1912) suggests, for the breeder of plants the environment is of first-rate importance, for it often sets a very definite limit to what he can accomplish. Our better varieties of apples and carnations can reach their full perfection only under closely regulated conditions; and improvement is frequently made possible only when we find means of improving the environment. Nurture, in the wide sense, must remain a matter of extreme importance for the race, even if, as seems likely, its effects pass away with individual life.

Weismann, the great German biologist, has given the basis for this belief in the non-inheritance of acquired characters, in pointing out the fact that germ and body plasm are quite separate, the germ plasm depending on the body plasm only for its nurture. The body plasm responds quickly to external changes, but this tissue is but temporary and lives for one generation only, while the germ plasm is carried over from one generation to the next. Characters to be inherited must be impressed upon the germ plasm. At present no way is known by which the body cells can influence the germ cells other than by transfer of food.

Modern observation, through experimentation, has established the fact that hybridity does not necessarily mean weakness. On the contrary, in many cases hybrids have attained greater vigor than their parents. The modern gladiolus, with its great size of bloom and vigor, is superior to any species as yet employed in hybridization. Very probably this progress in vigor is due to hybridity and continued selection rather than to the inheritance of any acquired character resulting from modified culture or ecology. Plant breeders in the main have rejected the theory of Lamarck that races are developed by the accumulation of the effects of use and disuse, because experimental data are lacking to substantiate the contention. Colors do change, often due to a changed environment; but, as Goodrich (1912) explains, each variety will reproduce its like in its own locality; but seeds of an alpine plant (he has been speaking of a divided dandelion plant, one-half planted in alpine altitudes, the other half upon the lowlands — each has developed new characters) will produce only the lowland form if sown there, and vice versa; the seeds of the lowland form will grow into the alpine form in the mountains. This change is accomplished by the new growing tissues, for the old and already-formed tissues are no longer capable of altering. Once fully differentiated, they are fixed. So we see the organism is moulded by its environment. It is not the developed result which is transmitted; it is not the modification which is inherited, but the capacity for modification in certain directions — the modifiability.

Besides white, which is due to the absence of color pigments, there are three classes of colors in flowers — the plastid, the cell-sap, and the combination colors. Plastid colors are resident in chromoplasts, the colors of which vary from yellow to red (Bailey and Gilbert, 1915) according to the predominance of yellow xanthophyll or orange-red carotin.

Cell-sap colors are often due to a chemical substance known as anthocyanin, which is (Bailey and Gilbert, 1915)

blue in an alkaline and red in acid reacting cell-sap, and, under certain conditions, also dark red, violet, dark blue, and even blackish blue. . . . The different colors of flowers are due to the varying color of the cell-sap, to the different distribution of the cells containing the colored cell-sap, and also to the combinations of dissolved coloring matter with the yellow, orange, and red chromoplasts and the green chloroplasts. There is occasionally found in the cell-sap a yellow coloring matter known as xanthein; it is nearly related to xanthophyll, but soluble in water.

Xanthophyll is the yellow pigment in chloroplasts. To summarize the nature of these colors, Bailey and Gilbert (1915) write:

Yellow, cream, and related colors are due to a yellow pigment either associated with green in the chloroplasts or found alone in the chromoplasts, generally the latter. Yellow may sometimes come from the cell-sap.

Red color may, under certain circumstances, be due to the presence of that pigment in the chromoplasts, but it is ordinarily a cell-sap color.

Most of the remaining colors, purple, blue, generally red, pink, etc., are due to pigments in the cell-sap.



The colors in the third class are the result of both cell-sap and plastid colors. They are termed *combination colors*. Judging by cases of *Gladiolus primulinus* hybrids noted, this species seems capable of altering the colors in such a way that the bright reds are subdued to salmon, apricot, écru, and cream yellow, no doubt traceable to a dilution of the cell-sap reds by the yellow plastid colors from *G. primulinus*. The resulting colors are combination colors.

Reciprocal crosses are crosses in which both the male and the female functions are served by each plant; in other words, crosses in which each parent is used alternately as a seed bearer and as a pollen producer. Naudin (1866), in describing crosses between *Datura ferox* and *D. laevis*, says that the two groups of offspring of this reciprocal cross were so identically like each other that the two sets might easily be regarded as one. In other words, either species could be alternated as pollen or as seed parent without an appreciable difference in result. Darwin (1888) writes: "Hybrids raised from reciprocal crosses. . . . rarely differ in external characters." Colonel Trevor Clark found no difference in reciprocal crosses between *Begonia Dregei* and *B. heracleifolia*, or *B. cinnabarina* and *B. Pearcei*.

With gladiolus the results seem to differ from the above-mentioned cases, perhaps due to the extreme hybridity. Lemoine obtained *Gladiolus nanceianus* by crossing *G. Saundersii* and *G. Lemoinei*, *G. Saundersii* being the seed parent. The reverse cross gives many fine flowers, but none so rich in color nor so characteristic in shape. *G. Colvillei* is the result of crossing *G. cardinalis* on *G. tristis concolor*, and the reciprocal cross is not mentioned as being identical. In R. T. Jackson's hybrids between *G. gandavensis* and *G. purpureo-auratus*, the latter was used as the male parent; the reverse order gave little success, but no notes were kept. It is generally considered that *G. gandavensis* is a good seed parent, as results were better when it was so used with *G. purpureo-auratus*, *G. dracocephalus* (figs. 28 and 29), and *G. Saundersii*. Perhaps in all these cases the species were not pure types, but hybrids; in which event seedlings of the generation first observed would vary among themselves as much as they would in reciprocal crosses. When one parent is stronger or more vigorous than the other, obviously the stronger one should be used as the female because of a supposed superiority for seed production. In many cases a morphological characteristic causes an incompatibility between the parents. The style of the pistil may be so long that the pollen tube of another species cannot fertilize the ovules.

In A. E. Kunderd's mind the ideal was a strain of gladioli which should have ruffled segments. For more than twenty-five years varieties showing a tendency toward ruffling have been in existence, such as White Lady



PHOTOGRAPH LENT BY ERNEST BRAUNTON

FIG. 28. GLADIOLUS DRACOCEPHALUS HYBRID

A. *Gladiolus dracocephalus*, a wild species characterized by having a dull yellowish green bloom finely marked throughout the perianth with brownish red.

B. A scarlet seedling designated as No. 1 Scarlet by Ernest Braunton.

C. The hybrid between *G. dracocephalus* and No. 1 Scarlet. It is intermediate in color, the perianth bearing the characteristic *G. dracocephalus* markings and the larger flaring form of the pollen parent, No. 1 Scarlet.



and especially Safrano. Kunderd has for a number of years selected such varieties, and has bred them together until he has a type that is rather distinct from any of the others, not only in the matter of ruffling but also in shape of bloom (fig. 30).

There are several ways of explaining the origin of these varieties. There is a possibility that they are progressive mutations; in other words, that a tendency toward waving arose by a sport and continued to intensify. Another explanation is to consider ruffling as due to several factors variously combined to cause a gradual progression in the degree of variation.

#### CROSSING TECHNIQUE

The normal, complete flower of the gladiolus consists of a showy six-parted perianth, of no practical value in the production of seed. Attached to the perianth are three stamens, with rather fleshy filaments, and anthers which in many cases are rather large; the varieties differ widely in this character. Most varieties are abundant pollen bearers, but the variety Rochester White, because of its complete albinism, produces no pollen. The

pollen is of various colors ranging from white to almost blue. From the center of the flower rises the long pistil, bearing aloft the three-forked stigma. When the stigma is mature, which is a little time after the stamens begin to shed pollen, the surface becomes rather feathery and



FIG. 29. AMERICA  $\times$  GLADIOLUS DRACOCEPHALUS  
The hybrid is indian red penciled and flecked with yellow and bronze. This is one of Ernest Braunton's hybrids

is then receptive to pollen. The flowers are usually protandrous, which means that the stamens and pistil mature at slightly different times. It is interesting to note that in *Gladiolus segetum* the pistil curls down to receive the pollen, the stamens and pistils being ripe simultaneously.



FIG. 30. AZALEA, A RUFFLED VARIETY

The first operation in crossing is to protect the pistil from foreign pollen or pollen not wanted as a parent of the cross. This is done by taking out the stamens or removing the whole corolla to which the stamens are attached. This process is known as emasculation. Unless the stamens are removed when they are undeveloped, which is before the bloom opens, the purpose of this operation will be defeated. W. C. Bull and L. M. Gage consider emasculation unnecessary, but the fact remains that pollen often retains its fertility until the pistil is ripe. In many cases the top of the spike is removed in order to concentrate the energy of the plant on the flowers remaining.

At the time the spike is removed, the emasculated flower is usually bagged, in order to keep out bees. The method of bagging differs greatly. E. N.

Fischer uses a special hood consisting of a wire frame covered with cloth, the wire projecting at the bottom and the hood closed by a piece of tape fastened to the cloth. Much experimental evidence is presented to show that cloth bags do not absolutely keep out foreign pollen, so that for scientific results a waxed paper bag should be used,



which will admit the sunlight and will also protect against contamination by other pollen.

The various methods of pollination are best tabulated for comparison. The significant points to be borne in mind are: (1) that the pollen is shed almost as soon as the flower opens, which is as soon as the sun is up; (2) that perhaps self-fertilization takes place much more readily than one thinks, since it is a rather easy matter for the pollen to reach the pistil either by the action of insects or by the wind. This makes emasculation in the case of the gladiolus more necessary than for some other flowers.

The workers in the Bureau of Plant Industry at Washington, D. C., according to Dr. C. E. Leighty, carry the pollen in a small vial, which is secured to the thumb of the left hand by means of a rubber band, thus allowing full play to the fingers. In the right hand the worker carries either a pair of forceps with which to remove the stamens from the vial, or a small brush to be dipped in the pollen.

Douglas (1885) dusts the seed-bearing parents about four times. "It is easy to do this," he writes, "because at the time of setting the blossoms we go over the flowers twice a day.

In the morning between nine and ten, and in the afternoon between two and three."

After pollination the bags should again be placed over the blooms, in order that foreign and undesired pollen may not come into contact with the stigma and be more congenial to the pistil than the pollen applied previously.

It is always desirable to carefully label the crosses. This is best done



FIG. 31. CROSSING TECHNIQUE

By reference to figure 14 one may see that the stamens are attached to the perianth tube. Therefore, if the perianth is removed, the stamens are removed. This is a simple method of emasculation



FIG. 32. CROSSING TECHNIQUE

A small vial is secured to the thumb of the left hand by means of a rubber band; the fingers are thus left free to hold the flower. With the right hand the stamens are easily removed by the use of forceps, and dropped into the vial

Name of grower	When emasculation is performed	When pollen is applied	Method of pollination
Austin.....	Morning or late afternoon.....	When pistil seems ready.....	With anther
Barber.....	Does not emasculate.....	Midday.....	With entire stamen. Piece of flannel placed in flower so that pistil is held against upper petal where bees will not touch
Barnes.....	Morning before pollen is shed.....	10 a. m., and throughout day.....	With camel's-hair brush, and finger tip
Betscher.....	Morning.....	4-30 p. m.....	With small penknife. Anther used. Less danger of getting foreign pollen
Bonvallet.....	When flowers open.....	When pistil is fully developed.....	With anther
Burbank.....	Morning before bees fly.....	Forenoon.....	With brush
Fuld.....	Early morning.....	9 a. m.....	With any instrument
Gage.....	Does not emasculate.....	9-30 a. m. to 2 p. m.....	With anther and finger nail
Hoeg.....	7 a. m.....	Morning or noon.....	With brush
Hutchinson.....	Early forenoon.....	Afternoon.....	With stamens
Richardson.....	Morning, two or three days before pollinating; opens the bud.....	Mid-forenoon.....	With entire stamen
Tait.....	Morning.....	Noon.....	With teaspoon. Pistil dipped in pollen. Brush also good
Thomann.....	Early morning when flowers are only partly open.....	9 to 10 a. m., if bright.....	With piece of wood
Tracy.....	Early morning.....	Early morning.....	With brush
Van Fleet.....	5 to 8 a. m.....	10 a. m. to 12 m.....	Anthers applied to receptive stigmas by means of forceps
Weathers.....	Early stages of flower.....	An hour or two before midday.....	With stamen
B. F. White.....	When flowers are open.....	Whenever pollen can be obtained..	With camel's-hair brush
Wilmore.....	Before flowers are fully open.....	Noon hour.....	With camel's-hair brush $\frac{1}{4}$ inch in diameter
Zecstraten.....	No special time.....	Just as flower opens.....	With stamen



by using small watch tags and placing on them the time of emasculation as well as the date of pollination, together with the name of the pollen parent. Perhaps a number which refers to a record book will be sufficient and more satisfactory than writing the full name of the parent.

There is a difference of opinion as to the number of seed capsules to be allowed per spike, some growers holding that as many should be allowed to develop as will, others that the strength of the plant should be concentrated into a few seed capsules only. Seed production is thought to exhaust the corms, so that few capsules should be allowed to develop if they are not wanted.

### POSSIBILITIES FOR IMPROVEMENT

#### USE OF WILD SPECIES

In the hybridization of the gladiolus only about a dozen species have as yet been incorporated into hybrids. For some years many hybridists have been working on the use of other species. Some think that great future progress is to be made by their use; others feel that the species thus far used include all that are of value. When one considers the value of the various species in producing new types and diverse blotchings and stripings, it is difficult to believe that there is no further possibility along this line.

The first species to be used extensively in hybridizing was *Gladiolus cardinalis*, which gave the excellent white throat lozenge to the *G. Colvillei* hybrids. The next species of great importance was *G. oppositiflorus*, a form contributing height, length of spike, arrangement of flowers, and markings, to its hybrids *G. ramosus* and *G. gandavensis*, for this species attains a height of six feet and bears from twenty-four to forty blooms, which are arranged so as to face in two directions. It has taken years of breeding to eliminate this last character, which is rather objectionable. Most of the *gandavensis* varieties are also marked with the characteristic stripes or penciling from the *G. oppositiflorus*.

Another species concerned in the *gandavensis* strain is *G. psittacinus*, which has given its rich scarlet and chrome yellow to the hybrids, *G. oppositiflorus* being a white species. Some years previous to 1878, *G. purpureo-auratus* was used in crossing. This introduced, through the *Lemoinei* forms, the bell-shaped, hooded blooms facing in one direction, as well as the diamond-shaped, rich maroon blotch characteristic of the varieties at present so popular. *G. Saundersii* has had its influence on the *Childsii*, *nanceianus*, and *turicensis* varieties in making the blooms large and exceedingly well open. *G. cruentus* has contributed the charming white throat and fine dots found in the variety *Princeps*. *G. papilio* is usually credited with the production of the finest blue varieties. Recently there

has come to the attention of the breeder the Maid of the Mist gladiolus (*G. primulinus*), a pale yellow, primula-scented, hooded species which has toned down the deeper colors of the other varieties and impressed its hooded character on the majority of its seedlings.

The foregoing discussion covers only a few of the species used. In the practical hybridist's mind, each species represents certain desirable char-

acteristics to be incorporated into a hybrid. Too often there are many unfavorable features, the consideration of which should not be entirely neglected.

Dr. Van Fleet and Maurice Fuld are optimistic of the results in using new species in the future. H. A. Richardson writes that the "infusion of new blood at any time offers a promising field as a basis for further selection and improvement." S. E. Spencer feels that the wild species are valuable "to a limited extent to get vigor and hardiness and develop new types and colorings." W. W. Wilmore, jr., notes that "the wild species may be used to develop some lacking



FIG. 33. RUFFLED PRIMULINUS SEEDLING FROM L. M. GAGE

The color of this variety more closely approximates orange than any other variety seen. It shows the characteristics of its parent *Gladiolus primulinus* in the hooded bloom and penciled throat, as well as in its color. It is beautifully frilled and ruffled

quality," otherwise a backward step is taken. W. C. Bull thinks it is very doubtful, so far as form and color are concerned, whether the gladiolus can be improved by the use of wild parentage, but "if constitution could be improved it would be worth any amount of time and trouble." B. F. White feels that at present the species are not promising, as all "the good ones have been tried. Should new ones be discovered, it would pay to try. The farther we get away from the species, the better the flowers



are." C. Betscher believes that "few species are needed, for quite as many points can be secured without them." Luther Burbank writes that "it is slow, uncertain work when using wild species."

Groff (1907 a) believes the only system to follow for the production of the highest types for commercial value, is that

of breeding from domestic specific types as sires on selected females. . . . The use of wild species with the hope of attaining a similar ratio of such results is relatively absurd, as the only value that any wild species can have to a breeder for practical results is as foundation or laboratory stock, to be discarded yearly with their early hybrids as he advances step by step towards his ideal.

\* \* \* \* \*

. . . By using all obtainable species he multiplies the possibilities for practical results and increased diversity in the material to be evolved from the product of future years, and yearly discarding species and early hybrids as they are superseded in the course of his operations.

Wild species are only of value so far as they may supply some desirable quality for incorporation into a domestic type containing other good qualities, such as size, vigour, vitality, and adaptability. . . .

. . . Breeding from wild species is therefore of little practical value, as the farther our removal from their many objectionable features the better, when by proper selection their best qualities can be controlled and applied according to our knowledge and discretion.

\* \* \* \* \*

How many animal-breeders would be satisfied with sires whose progeny were largely weeds? How were these high-class animal sires produced? How are new domestic races and strains of cattle, sheep, dogs, poultry, pigeons, and other animals and birds obtained? Certainly not by the general practice of plant-breeders.

Of what practical value is the knowledge of the component ratios of life forces in simple hybrids, in comparison with that knowledge giving results in the highest ratios of useful and valuable qualities? — thereby saving labour, time, space, and expense, and giving, in the place of curios, the highest possible percentage of quality in economic types.

. . . Select and develop domestic races and sections of such high quality, vitality, and general adaptability, that their progeny will not only be of higher quality than the parents, but that this quality will be produced in quantity in the highest possible ratio. This is practical plant-breeding.

Again, before the American Breeders' Association, Groff (1907c) expresses his opinion "that no simple or limited crossing can produce the value, quality and satisfaction equal to those resulting from unlimited removals from the wild species on the lines of scientific selection, guided by learned human intelligence."

As has been stated by the writer in a previous paper (Hottes, 1915 a), it must be admitted that greater progress can often be made by interbreeding established varieties; but when new features are to be added, the employment of new species is advisable, or even imperative. These should be the basis of hybridization. As years pass, the inferior seedlings may be discarded, and the ideal form may be far removed from the wild species; but the ancestor is necessary.

## THE MOST NEEDED IMPROVEMENT

In answer to the question, What is the improvement most needed, M. Crawford, Van Fleet, Spencer, Fischer, Richardson, and Bonvallet consider clear and self colors a great ideal for which to strive. Richardson, M. Crawford, Flanagan, Burbank, Black, Spencer, White, and Fischer consider it necessary to make an effort to greatly increase the substance of the bloom. Healthier plants should be the only ones retained; all those of inferior quality should be barred from distribution and destroyed. Slender, graceful spikes should be developed, write Mrs. Austin, Zeestraten, and Fischer. Wide-open flowers are preferred by Mrs. Austin and by Van Fleet and Richardson. Mrs. Austin, Koerner (1911), and Spencer welcome the introduction of new and unusual forms. Kunderd (1911) writes:

In addition to the reported foliage with white striping, great improvement may be expected with the normal color. For a number of years I have been selecting and breeding with this object in view, and find the gladiolus as susceptible along this line as in the improvement of its flowers. We should have tall, wide, rich green foliage: tall, slender and graceful foliage, of forms best suited to the usual straight-stemmed varieties, and some beautiful, slender and drooping foliage, best suited to blend with what are known as bent or crooked-stemmed varieties. That there is a future of usefulness for the last named form of stem, I feel confident, if the flower is specially attractive.

Another feature of promise is the colors of the stem. Some of the stems are almost white and others are fine cream or yellow. This, no doubt, will become a feature of usefulness in the gladiolus of the future.

. . . I am confident the long wished for sweet-scented varieties will be perfected in the hands of Lemoine, Burbank, or Van Fleet.

Fuld emphasizes the value of having an ideal toward which to work. N. L. Crawford wishes that growers would attain a higher ideal before putting their varieties on the market. Zeestraten would have a better shape in the gladiolus. Gage thinks the whole *Lemoinei* class needs improvement.

As to the type of bloom the hybridists are using as the parents to attain the high degree of perfection desired, Groff (1907 a) writes: "For practical and valuable economic results it is therefore not sufficient that the breeder should be able to produce types of symmetry and beauty, but he must add the qualities of stability and adaptability to changed conditions to ensure due satisfaction for the ultimate grower." Wilmore thinks the variety America is the best type of parent, as it produces seed freely, is vigorous, and is of a color that blends well. Thomann uses light colors only as parents. Mrs. Austin, Burbank, and Betscher use seedlings, mostly of their own origination, which combine the different types. Van Fleet believes "*G. primulinus* and the garden varieties to be most promising." Fuld is breeding for size, and therefore uses the larger-blooming varieties. Zeestraten uses the most vigorous growers and the best multipliers.



The following varieties are mentioned as having possibilities when used as parents:

America	Mastodon
Badenia	Mrs. Frank Pendleton
Baron Joseph Hulot	Mrs. G. W. Willock
Blanche	Niagara
Blue Jay	Panama
Canary Bird	Parure
Chicago White	Peace
Cordelia	Princepine
Dr. Dotter	Princeps
Elizabeth Kurz	Princess Louise
Europa	Prophetesse
Glory	Rochester White
Golden King	Schwaben
Halley	Sparta
Harvard	Sulphur King
Heliotrope	Victory
Isabel	White Excelsior
Lady Howard de Walden	White Lady
Liebesfeuer	

### GATHERING AND PLANTING SEEDS

After the fertilization of the ovules the capsules soon begin to develop, and when they have attained their full size they ripen speedily. The pods crack from the top downward, and the seeds can be gathered as soon as this takes place. They should be dried in an airy room. The pods or the seeds may be placed in cloth sacks to which air can be admitted. It is necessary to remember always that seeds are young plants and for their proper germination should be stored in a cool, not too dry, place.

Opinions differ as to the proper time for sowing. Fuld prefers to sow the seeds in December in the greenhouse, and then have some young corms to set out in May, thereby saving a year in the production of new varieties.

Douglas (1885) writes as follows:

My plan is to prepare a hot-bed for them, and to sow about fifty seeds in a seven-inch pot, using good light compost. The seeds vegetate in two weeks, and the way to be successful is to keep the young plants growing on without any check. The plants grow very rapidly, but it is best not to disturb them. As they increase in size, gradually admit more air, until by the end of May the lights may be removed entirely; placing them over the frames only in very rough and frosty weather. By the end of September or not later than the middle of October, the young seedlings have completed their growth, and the pots will be full of bulbs varying in size from a marrow pea to a filbert. The pots may be laid on their sides until the leaves decay, when the next step will be to shake the bulbs out, wrap them up in paper, and store the packages in a dry place where frost cannot reach them.

Somewhat the same system is in vogue with Jackson (1889), who writes:

The hybridized seeds were planted in April, 1886, in shallow boxes, and so grown throughout the summer. About midsummer, when the leaves attained a considerable height, fine sifted cow-manure was spread over the soil in the boxes to the depth of half an inch or more. This proved beneficial as a mulch and source of liquid-manure at each watering. In autumn the bulbs were sifted out of the earth. . . . The second year the seedlings were planted thickly in rows in the open ground.

Gage (1913 ?) gives the following directions for the care of the seed bed; he recommends sowing out-of-doors about May 15, when the ground has become warm:

Many growers place their gladiolus seed bed under shade during the first year, but I think that this is wrong, for after testing both methods I am convinced that seedlings grown under shade do not produce as large or as strong corms as those grown under the open sunshine.

It is, of course, desirable to keep the seed bed covered with matting or other suitable material for two or three weeks after planting, to conserve the moisture and facilitate germination; but after the seeds have started to grow and roots are formed, the bed should have an abundance of air and sun; also plenty of water should be added if the bed is liable to suffer from drought.

I prefer to have the soil in my bed rather sterile, because the weaker seeds will not survive long in a poor soil and much of the struggle for existence—for the survival of the fittest—is ended in the seed bed and I am thus saved the labor and bother of growing weaklings; but after the plants are well started I begin to feed them, giving them an occasional top dressing of some good commercial fertilizer, and later I apply hard-wood ashes.

Hendrickson (1911) writes that seed

will have to be carried over until the following spring, when it can be planted in shallow drills, covering about one-eighth to one-fourth inch with soil, they will only make a slight grass like growth the first year, and must be taken up in the fall and housed away from frost; the following spring they can be planted as one would sow garden peas and covered about one and one-half inches deep; they will make a little more growth and perhaps a small percentage will flower, but the bulbs will have to be lifted and planted once more before a good showing of flowers can be expected.

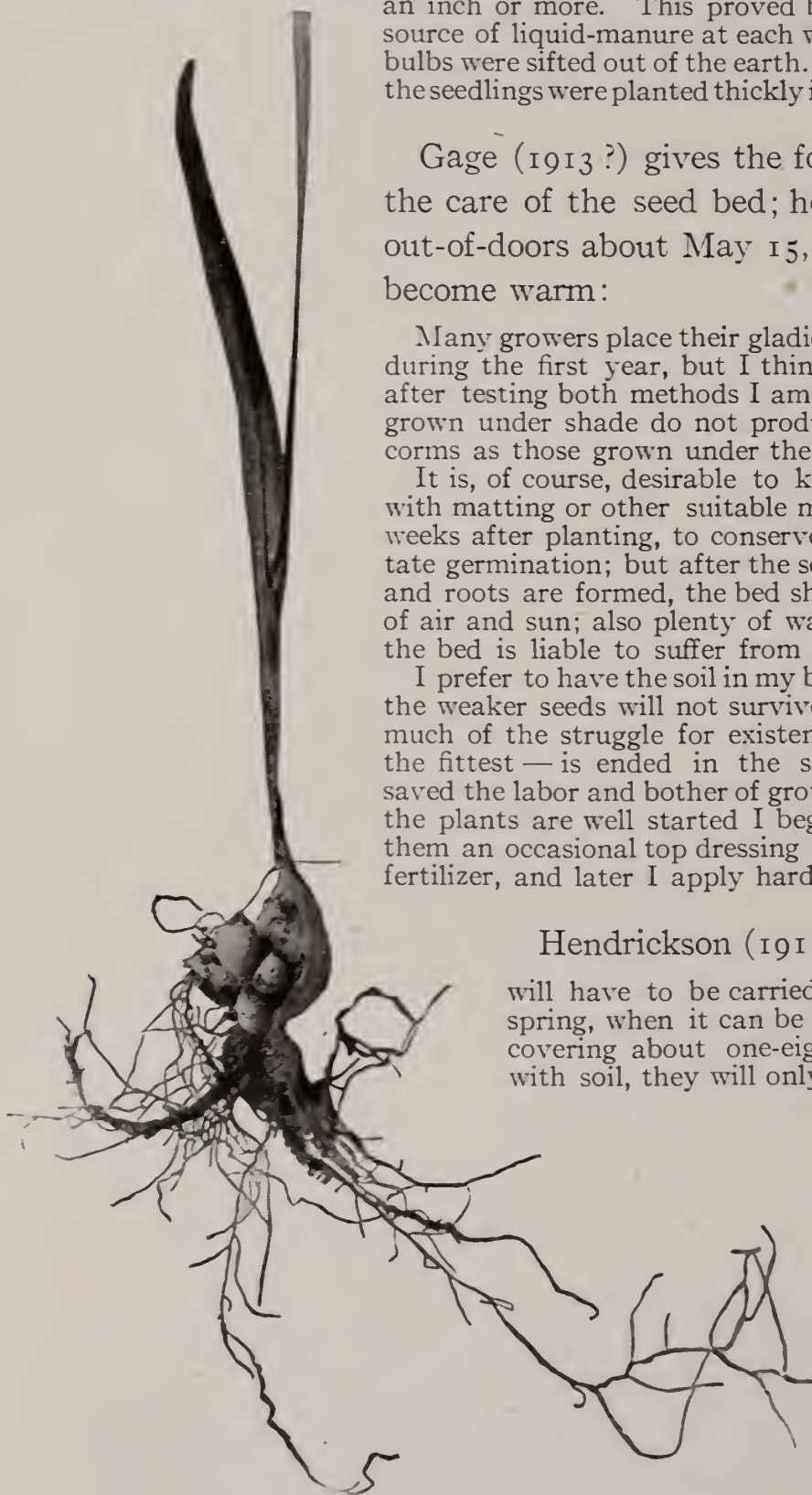


FIG. 34. GLADIOLUS SEEDLING

Note the thick roots at the base and the large corms. This is shown after six months' growth from seed



Betscher (1914 a) gives the following excellent suggestions regarding seed beds:

Presuming that one has good soil to begin with the next step is the right handling of it. Where possible to do so, it is very good to have the plot planted to clover — alsike planted about July 15 or rye later on — and given a good mulching of manure, but not heavy enough to ruin it. This will feed the clover and leave the ground in extra fine shape. When severe freezing sets in about November 15, or later in an open winter, spade the plot about eight inches deep, turn so top soil and clover is at bottom, leaving rough so that freezing will penetrate deeply. About January when an open spell comes as soon as it gets colder and the top is frozen two or three inches deep, dig this plot up with mattock or pick about three to four inches deep so that it will freeze deeply, leave as rough as possible. We do this a number of times during the winter but not after severe freezing is at an end. . . . When a severe change to colder, about March 15 or later rake it level, and even if a bit wet the freezing will leave it very fine. This will bring out early weeds so that when the soil is ready to plant about April 15 or later it may be hoed and raked thoroughly. It will be in fine shape to plant any time after April 15 in central Ohio.

Granting that the soil is in very fine condition — perfectly level — we now begin to plant. Very often ground is not what it should be, and seedlings do not turn out well. For this reason we plant several rows of large bulbs alongside and if soil is wrong the large bulbs also will show it.

Our beds are about forty feet long. We take several eight inch boards to walk on. Then take a wide flat shovel and scoop out the soil about three-quarters to one inch deep. Make perfectly level with back of rake. Make beds from four inches to twenty-four inches wide. Plant seed quite thick so ground is covered; then scoop soil and cover seed carefully. We level carefully before moving boards ahead so rain does not form puddles on the beds. In this way we plant thirty-five to fifty pounds of seed.

These beds may be covered with old carpets, old sacks or burlaps, and left on until plants are two inches high. Mats or straw may be used.

Until seed is pretty well up it should be kept damp say for four or five weeks after planting. Water evenly and thoroughly.

Whenever the beds partially dry out we give them a thorough watering. *Never let the seedling bed get dry.*

We prefer watering very early in the morning, but in hot dry weather about sundown. When done thoroughly it may be done any time during the day.

Planted so thickly it soon requires feeding. We have a heap of well rotted manure to which has been added bone flour, wood ashes, soot and lime mixed one part to which we add two parts good soil — mix thoroughly — sieve through fine sieve and put evenly through the plants about June 20 and July 15. This must be done with care. We water as fast as we get several beds mulched so ammonia, etc., does not escape. Do not put on too thickly.

Go over the plants often. Do not let weeds get a start; once a week is best.

When planted April 15 to April 30, they will be ripe enough to dig August 15. Earliest types August 1 — latest types about August 30.

Do not sieve or rub much. We loosen the soil with a stiff trowel then pull the plants out, sieving the balance lightly, although it is better to pick out all that do not pull out.

Put in shallow boxes about two inches deep, then put in a dry cool shed or cellar. Do not leave where winds or drying occurs as often they harden easily, especially so when bruised in sieving. Rub roots off lightly when ready to plant.

\* \* \* \* \*

*Do not keep near fire heat as they deteriorate greatly.*

Plant about April 10 to May 15 three inches deep below soil level. Draw the rake through them when coming up. Do this every week or after every rain until plants are about eight inches high. Keep soil loose about them until August. Many perish if ground becomes crusty.

Thomann sows his seeds in flat trays in early March and takes the trays out of doors when the weather permits. The plants should be disturbed as little as possible. Van Fleet uses six-inch pots, or if sowing

in May he prefers seed beds. N. L. Crawford scatters the seeds in three-foot rows, six inches wide, covering the soil deeply with leafy boughs until the sprouts appear. He protects the seedlings with a cheesecloth screen, placed about one foot above them, during the heat of the day. Burbank sows his seed both in beds and in boxes. Huntington keeps his seedlings under lath screens. Wilmore drills his seed in trenches, which are made ten inches deep to allow for irrigation and hoeing. Black covers his seed with a layer of sandy soil. M. Crawford believes straw to be the best material to use for covering in order to insure germination.

About 1906 Frederick Roemer, of Quedlinburg, Germany, originated what he called a new group, giving to it the name *Gladiolus praecox*. By some growers the varieties in this group are called *Annual gladioli*. This term should not be used, since annuals are plants that live for only one year, whereas the meaning in this case is that the plants are brought into bloom in one year from seed. The *praecox* strain is obtained by intercrossing the earliest plants of *G. gandavensis*, *G. Lemoinei*, *G. Childsii*, and *G. nanceianus*. The seeds (Anonymous reference, 1907 d, should be started in a temperate frame the first of March. They germinate in from three to four weeks. As growth advances and weather permits, ventilation should be given in order to get good, sturdy plants. A transplanting, although not essential if the seeds have been sown thinly, is of great benefit. Soon the seedlings are strong enough to stand feeding, and a mulch of bone dust or sheep manure should be applied. During the first year the corms attain the size of a crocus bulb; the second year they are as large as those usually offered in commerce. Two-years-old corms produce two or more spikes of normal size.

Burpee seems to have evolved a strain much like the *praecox*, which he calls *Fordhook hybrid gladioli*. Some of these seedlings seem to be very excellent both in color and in size. It is of great value to get such precocious varieties.

Kerr (1913) prefers to sow the seed where it can be left to bloom, as the seedlings do not transplant well. He states that great pains should be taken to give the bed a careful preparation before planting the seeds.

## THE CORM

The underground stem of the gladiolus is not a bulb, but a corm. A corm is defined as a thickened base of a stem, usually subterranean, in which food is stored. It differs from a bulb in that the greater share of the bulk of a bulb is not stem, but bulb scales, which are really thickened bases of leaves, the stem being merely a much-flattened plate from which roots and bulb scales arise. Corms also are covered with tunics, or scales,



but these are scarios, and are called husks, or tunics, in the case of the gladiolus. These scales are bases of leaves, but are not thickened as they are in bulbs. Botanically considered, a bud or the potentiality for a bud exists in the axils of all leaves. There should be one bud for each layer of tunics, or husks. Because of the manner of growth of the gladiolus, which is in one plane, these buds should have an opposite arrangement, thus causing them to lie in one straight line through the center of the corm.

It takes from one to four years, according to the variety, for a seedling to produce a corm of blooming size. It takes one year less for a cormel to flower. *Gladiolus purpureo-auratus* has the character of blooming quickly from seed, and has transmitted this character to its offspring; it was therefore a great factor in the production of the *praecox* strain.

Every stem that makes vigorous growth has at its base a corm. Each corm has several buds, of which each one that grows will produce a new corm on top of the one planted. Seven bulbs of blooming size in one season are reported by Higgins (1912). In this way the grower's stock is not only reproduced each season, but also rapidly increased, provided good soil and proper cultivation are given.

The vigor and the thickness of a corm depend much on the proper growth of foliage. If in cutting the spike little vegetative growth is left above the soil, only small quantities of food can be manufactured by these abbreviated leaves, and the base of the stem, or corm, in which the food is stored, suffers. The failure of amateurs to carry over stock is often due to cutting the shoots near the surface of the soil, the corms thus being able to make little or no development. The suggestion, then, is that if one wants an annual renewal of corms, care must be exercised to leave sufficient foliage after cutting the spike.

It is the general opinion that corms which have been allowed to bloom every year for three or four years become thinner and thinner. These



FIG. 35. GLADIOLUS CORM  
The husks, or tunics, are really the bases of the last year's leaves



FIG. 36. GLADIOLUS CORM FROM WHICH THE TUNIC HAS BEEN REMOVED

Note the scars due to the bases of the old leaves. The buds are in a straight line, and there is one bud for each ring on the corm



FIG. 37. FIVE CORMS FROM ONE

When the corms have produced flowers for a series of years, they become flatter. When corms of this kind are planted, they often produce five or six small-sized corms instead of one or two of blooming size

thinner corms do not produce long-blooming spikes. So that in order to maintain the quality of the bulbs and the correlated quality of the blooms, very old corms should not be allowed to bloom, or else new stock must be grown from cormels. The more nearly spherical corms, in other words the thicker ones, are the better. With age the flat corms frequently send up five or six shoots, causing the production of not one or two blooming-sized corms, but small ones that need a year's growth before they will bloom again. However, corms vary greatly in size, it being the characteristic of some varieties to produce small corms. It is usually blooming age, rather than blooming size, that is important. In choosing corms from mixtures, therefore, it is not wise to select only the large ones. Some of the blue hybrids produce small corms, and this color might be omitted if large corms only were purchased. The variety Baron Joseph Hulot never produces as large a corm as do some of the other varieties, and many varieties, for example Mrs. W. E. Fryer, produce flowers from very small corms.

Corms are graded officially by the American Gladiolus Society as follows:

Grade	Diameter
1st, or no. 1.....	1½ inches and up
2d, or no. 2.....	1¼ to 1½ inches
3d, or no. 3.....	1 to 1¼ inches
4th, or no. 4.....	¾ to 1 inch
5th, or no. 5.....	⅜ to ¾ inch

Graded in this manner, numbers 1, 2, and 3 are of blooming size. Number 4 often blooms, but is usually sold only to the wholesale trade. Number 5 is not



supposed to bloom, but often does. The smaller sizes are sorted with sieves of from  $\frac{1}{2}$ -inch to  $1\frac{1}{2}$ -inch mesh. The other sizes are sorted by hand.

Endicott (1886) mentions the division of individual corms as a method of more rapid multiplication. He writes: "One way of propagating varieties is by cutting the bulbs into pieces. If a bulb be stripped of its husks, there will usually be found two large buds at the top and smaller ones in a line down each side, every one of which may be made to grow and form a bulb."

Mr. Banks, of England, according to Dombrain (1873), divides the corms into several pieces in the case of scarce varieties. If the corm is left entire, it often happens that one of the shoots will not start because of a decay, which infection may spread through the whole corm, causing its entire loss.

Woodruff (1915 b) takes the precaution to dust the cut surface with soot, although he is not persuaded that this is of real value.

It is a common opinion that gladioli change from one color to another after having grown for a few years, as already stated (page 225). This may be due to the rapid multiplication of some varieties and the more rapid deterioration of others. The slower propagation of certain ones merely increases their proportions. There is a greater tendency, it is thought, for the lighter-colored varieties to run out first; and the white ones are in all cases of rather weaker constitutions.

In the spring one often observes certain corms which have not been stored in the best conditions and which have turned brownish; though not diseased, they are considerably changed in color and dried. While actually the corms are not so good as normally colored ones, their change is due to a conversion of some of their starch into sugar. When planted they generally bloom well.

Regarding a correlation between color of corm and color of bloom, Cowee (1915 a) says:

Although we are able, from years of experience in handling gladiolus bulbs, to sort out from mixtures many named varieties by reason of color of bulb and other characteristics, I believe it is quite impossible to determine with any degree of accuracy the shade of bloom bulbs of certain colors will produce. From our experience we find that red shades produce a larger proportion of yellow bulbs, light, medium and dark (about 50 per cent), about 25 per cent of red bulbs, and about 25 per cent divided equally between white, flesh and pink. Pink shades rarely produce red bulbs, the shades of yellow predominating about 50 per cent, the balance being divided between pink and white bulbs, the latter predominating. White shades produce about equal quantities of white and yellow bulbs, a smaller proportion of pink bulbs, and a smaller proportion of red bulbs. Yellow shades rarely produce other than yellow and pink bulbs. Blue shades rarely produce other than yellow or white bulbs.

You will note from the above, which is a careful record of investigations made that it would be quite impossible to determine the color of flower from the color of the bulb.

The writer's observations show further that some of the corms are intermediate in color between red and yellow, while many can truly be

called white. For example, Blue Jay, Golden King, and Viking, respectively blue-, yellow-, and French-purple-flowered varieties, have white corms; while White Excelsior, Frilled Pink, Scarsdale, Lemon Drop, and Independence, although they are white-, pink-, magenta-, yellow-, and carthamin-red-flowered respectively, all have yellow corms.

#### STORAGE OF CORMS<sup>6</sup>

Gladiolus corms should be stored in a cool, airy place, not too moist nor too dry. The temperature should range between 35° and 50° F. in the coldest weather. If the storage house is protected sufficiently by dead-air spaces in the walls, little artificial heat is required. Large corms may be placed in crates; the depth is of less importance than when storing the smaller corms or the cormels, which become somewhat packed together, causing a heating due to fermentation. The small corms should be stored in shallow flats not over 2 or 3 inches deep.

Commercial growers handling bulbs on a large scale construct special storage houses. B. H. Tracy has a building that is thought to be fireproof. It is 80 feet long and 60 feet wide, and is constructed of concrete and terra cotta blocks with a "slapdash" finish. Enough space is afforded in the second story for a showroom, offices, and bulb storage space. The first floor contains the wholesale flower room, garage, carpenter shop, and additional space for bulb storage.

J. L. Childs has constructed his storage house of hollow cement blocks covered with stucco. The temperature during the winter is maintained between 40° and 50° F., a temperature which not only keeps the bulbs in good condition but is not too cold for the men to work about the building. The bulbs are placed in flats 3 inches deep, 30 inches wide, and 4 feet long. Throughout the entire room used for storage, racks are constructed 8 feet high, each rack holding seven flats. The first flat is placed 18 inches above the floor.

Oberlin (1891) writes substantially as follows of his storage method and the trays he uses: The cellar joists are 9 inches wide and 20 inches apart. It is this space that is used for storage purposes. Roofing laths are nailed 20 inches apart at right angles to the joists. The laths for another row should be placed 4 inches from the first so as to leave room for shifting and moving the trays. The trays are of plastering lath also, unplanned, 1½ inches wide, 4 feet long. Nine and one-third laths are required for each tray. If the following measurements are used there will be no waste material, the remaining two-thirds being used to make the next tray. Two laths are taken for the sides and 31½ inches are sawed from these; the other two pieces left for ends should be 15¾ inches

<sup>6</sup> The proper condition for the storage of cormels is considered under the discussion of cormels (page 250).



long. The end pieces are nailed, thin 1-inch nails being used. One lath makes three pieces for the bottom. From six laths eighteen pieces  $15\frac{3}{4}$  inches long are sawed. These are nailed to the bottom with a space between them equal to the thickness of one lath. The tray is finished by nailing two pieces at the bottom lengthwise. It is then lined with paper, and is ready to receive the corms. In this cellar three trays may be placed one above another. The work should be done in the spare moments of the dull season. In such a place the bulbs are away from dampness, and are in a temperature a few degrees higher than on the floor, as the living-room above communicates the heat to a stratum of air beneath the floor.

Many of the smaller growers feel that storage in the home cellar is as effective as in a special bulb storage house. Any place adequate for the proper keeping of potatoes over winter will be admirable for the storage of gladiolus corms.

It is best not to store in too deep boxes or in bushel baskets, since under such conditions the corms easily ferment and become heated.

Kunderd (1915 a) recommends the use of sand to cover the corms when small lots of each kind are maintained. It serves to prevent them from shrinking and keeps them in a good, plump condition. This seems especially advisable when frost may possibly enter the storage place. Furthermore it is a protection against too much moisture under damp storage conditions. Henry Youell advocates mixing fine, dry soil with the corms, which is sifted out at planting. He remarks that, according to the condition of the soil, some growers recommend dampening the soil immediately before planting.

### CORMELS

Soon after the base of the growing stem of the gladiolus has begun to thicken, small corms are found to have formed between the old and the new corm. These are properly called cormels. They are covered with a hard shell, thus differing from seedling gladioli of the same size, which have a covering more like a husk, composed of the dried bases of the previous season's leaves.

To keep up the standard of the stock and for rapid propagation, reproduction by cormels is essential. Cormels range from one-sixteenth to three-fourths inch in diameter, and will produce corms of blooming size in a year less time than will seeds. According to the variety, they flower in from one to four years. A single corm has been known to produce as many as two hundred cormels in a season.

Regarding the growing of cormels, Crawford (Crawford and Van Fleet, 1911) recommends having the soil as rich as possible at corm-planting

time. A bed four feet wide should be laid out and raked smooth. Drills should be made one inch deep and far enough apart to allow for hoeing (six inches). The bulblets should be placed one inch apart, and covered at once with sifted sand about two inches deep, then pressed down to the level of the surface. Sand is preferred to most kinds of soil, because it never bakes and also because it shows where the rows are so that hoeing

can be done before the plants are up.

Peeled cormels grow as much in one year as unpeeled ones do in two years (Falconer, 1891), and every cormel grows. M. Crawford's experience is that it is better to peel cormels the same day that they are planted; a number of his corms molded one year. It is essential that great pains be taken not to injure the cormels when peeling them, for any abrasion in the surface offers a place for the entrance of disease. If they are not peeled, they should be soaked for a day before planting.

The cormels should be planted early so that they may have a long season of growth, in order that they may gain



FIG. 38. GLADIOLUS CORM AND CORMELS

At the base of the large corm are usually found small corms, or cormels. These are unlike young corms; they are covered with a hard shell, or husk

a large size. Although it is advantageous for the same reason to allow them to remain in the soil until late in the fall, commercially they can be much more easily handled if taken up when the tops are somewhat green.

This leads to the question of proper storage, which is about the same as for mature corms. Cormels are often stored in soil (Moore) just as removed from the parent corms, in a place where the temperature is approximately from 40° to 45° F. (Wilmore), where they are always



moist and cool (Flanagan). Under these conditions they start much better than if dried out. C. S. Tait, a Georgia grower, writes: "When dug I pack them in dry sand, and they keep finely. I left them in the ground this season as we seldom have frosts that freeze deeper than one inch. They are coming up now [October 31, 1913]."

Cormels are frequently stored in cheesecloth bags, but oftener in trays. Thomann spreads the cormels on trays, grading them in three sizes by the use of sieves.

Summarizing, it may be said that cormels should be either peeled before planting, or soaked in rather warm water to soften their hard, dry coats. Besides this treatment, covering the bed with a burlap sack will result in a greater percentage of growth.

### INDOOR CULTURE

Almost since their introduction, gardeners have grown gladioli as pot plants. The *nanus* varieties, *Gladiolus Colvillei*, or the standard *gandavensis* and *Lemoinei* hybrids, may be planted with equal success. It seems inadvisable to use the term *forcing* in this connection, since that word often carries with it the idea of high temperatures causing a premature blooming. The gladiolus apparently does not stand such treatment.

The following species are mentioned by Endicott (1888) as being adapted to pot culture: *G. tristis*, *G. recurvus*, *G. gracilis*, *G. cuspidatus*, *G. Watsonius*, *G. villosus*, *G. Milleri*, *G. alatus*, *G. sulphureus*, *G. carneus*. Each of these species has small corms producing dwarf plants and small flowers. In late autumn they should be placed in four- or five-inch pots, in a light, rich soil.

*G. Colvillei* and its white variety, The Bride, have been grown under glass to a considerable extent, but the whole *nanus* group has been neglected. Many of the *nanus* varieties are three weeks earlier than the *Colvillei*. Moreover they are not quite so rigid, and in many of them the foliage maintains its deep green color to a much greater extent than does the foliage of *Colvillei* varieties, since the latter is very likely to turn brown, at least at the tips. As the season begins with the first of April or May the plants bloom at a time when few others are in their prime. The flowers do not all come at one time but their blooming periods vary, thus extending their season of usefulness for the florist.

The corms should be potted not later than the first of December, and preferably in October or November. If the corms are placed five or six in a five-inch pot or individually in smaller pots, they can be shifted to larger pots or transplanted to the greenhouse bench. If preferred, they may be planted directly in benches. Fuld (1912), in describing cultural methods, says:

Many commercial growers to-day plant it right between the carnations without giving it any extra space, thus getting two crops where formerly they reaped but one.

They are exceedingly slow in showing growth and actually make but little growth until spring when the sun rises higher. At that time carnations are plentiful and cheap and many growers throw them out, thus making room for the gladiolus, but that is not at all necessary. While the above method may perhaps be handiest, these gladioli can be better grown if planted in flats and stored away in a cold frame and brought in during February or March when even then they should be forced with only moderate heat.

A slow growth produced by gentle forcing allows the foliage to develop perfect but if much forced the tip becomes yellow and brown and injures the sale of the flower. . . . This type is often called "early flowering" and this is right because the flowers appear from two to three weeks earlier than the earliest variety of any other type.

The corms may be placed in flats twelve by twenty-four inches in size, and when planted in this way fifty or seventy-five corms are required for each flat.

It seems best to afford some method of staking the plants when they are not grown among carnations. Several stakes, one at each end of the rows crosswise of the bench, with string stretched between, are sufficient.

The *nanus* varieties are very susceptible to attacks of red spider, and unless thoroughly and frequently syringed the crop gets badly dried up, resulting in a poor development of the spikes.

A few sorts that have been tried by the writer and found inexpensive as well as pretty are:

Apollon — fine deep pink.

Mathilde — white, faintly suffused with lavender; early; rather dwarf; said by many to be superior to The Bride.

Pink Perfection — a very robust variety.

Blushing Bride — lilacy white (7-I)<sup>7</sup>, the throat sulfury white (14-III), bordered by rosy magenta (169-III); a fine, well-open bloom; early.

Peach Blossom — a dainty rosy pink (118-I) bloom with a Rose Neyron red (119-II) throat blotch, and sulfury white (14-I) medial lines; a little larger bloom than most of the *Gladiolus nanus* varieties, and early; one of the best varieties in the group.

Minerva — an intensely bright geranium lake (89-IV) bloom with splashed blotches of deep cherry red (91-IV) and carmine (116-II) medial lines; seems inclined to have rather poor foliage.

Jeanne Poter — a good dark pink or deep cerise (123-I), blotched carmine-purple (156-II), fading lighter toward the center; produces a large number of blooms, and is well furnished with foliage.

Duchesse de Parma — a good, bright poppy color (84-I), with throat of lemon-yellow edged with crimson-carmine; blooms possess excellent substance and are well arranged on the spike; rather late-blooming; tall.

Virginie — an exceedingly dainty pure white bloom, with faint markings of Rose Neyron red; a compact bloom of good substance; excellent-appearing spike.

Bertha Johannsen — excellent rosy pink (118-II), more salmony in appearance than Peach Blossom; there is no blotch on the lower segments, but a slight marking is often found on the upper lateral petals; blooms of good size.

Roseus Maculatus — excellent Rose Neyron red (119-I), blotched with deep cerise (123-IV), the medial line of which is lighter; good substance, but rather loose.

Ackermanni — rich salmon-orange or rosy scarlet (90-I) flowers, very large and handsome; spikes very strong.

Königan Wilhelmina — lilacy white (7-I), lower petals blotched with deep rose-pink (120-IV), medial lines of blotches lighter.

<sup>7</sup> These numbers refer to plates in *Répertoire de Couleurs* published by Société Française des Chrysanthémistes and René Oberthür.



The taller-growing and late-blooming varieties also are grown under glass to a great extent. Varieties are chosen for forcing which bloom early, have clear, light colors, and are vigorous and healthy. As before mentioned, one of the best methods of commercial culture is to place the corms among carnations. When planted in the short rows crosswise of the bench, they do not seriously interfere with the proper cultivation of the carnations. Cowee (1907), writing on this practice, says:

Most florists who force gladioli are apt to cut the spike too near the soil. . . . The bulb is damaged and will not the next year, either under glass or if grown outside, do as well. I have found that to give the forced bulbs one year in the ground before forcing the second time increases their vitality. . . . In solid beds I have produced excellent spikes in ninety days with the earliest varieties, but among carnations it usually takes from ninety-eight to one hundred and five days.

While the roots are forming on the bulbs, the temperature should not be over 50° at night, 60° during the day, but after they are well established 55° at night and 65° during the day is not too warm. . . . A light dressing of three parts of ashes and one of bone meal applied at the time of planting the bulbs will more than repay for the trouble and expense.

It is not necessary to first plant in pots, but most growers prefer to give the plants a good start by placing the potted corms underneath the bench in the carnation houses until good root systems are formed and tops are well started. If planted directly in beds the corms should be placed at a depth of two inches or more, for it is well to let the depth of planting provide a means of support.

Taft (1913) writes:

The bulbs need to complete their period of rest before they are started into growth, and nothing will be gained by planting them before the last of December, unless bulbs are used that have been forced the previous year. They can be grown either in beds, boxes or pots, but one of the latter will generally be found preferable, as it admits of keeping them in a cool place until the roots have formed, which is desirable. . . . It will be best to start them in pots and transplant them to the beds after the pots have become filled with roots.

They can be grown in the boxes about the same as Holland bulbs, using rather heavier and richer soil. The bulb should be barely covered with the soil, and as there is danger of the damping off of the shoots if over-watered, it is a good plan to have the surface half-inch of sand. Water thoroughly and place under the benches, where the temperature will be 50°, until the roots have filled the soil and the leaves have started. Gradually increase the heat to 60° and to 75°. When the buds begin to form, give liquid manure once a week. If properly handled, the flowers will be ready to cut by Easter.

Bebbington (1907) prefers to maintain a temperature of 50° at night and 60° in the daytime, and holds that a temperature of 70° is too high.

John Thorpe (Allen, 1911, pages 121-122), of Pearl River, New York, writes as follows of his experiences:

To force gladiolus successfully, however, requires attention at just the right time, and its wants should always be anticipated and supplied. Here is the routine of my practice: The bulbs I forced this year were also forced last year. They were then planted February 8, and the first twenty-five flowers were cut May 30. This year's work began December 27 by potting each bulb in a four-inch pot, using sandy loam, without manure, and placing the bulb on the top, pressing it down to hold it without any other covering; they were watered and then placed underneath the benches of

a carnation-house until the beginning of February. At that time those plants which had grown to the height of four inches were brought to the light and again watered. Placing them close together on a bench near the light, a little water was given from time to time, retarding the top growth, and encouraging root-action as much as possible. By the twentieth of the month the plants were gone over, and all those of an even size were planted together in rows about a foot apart, and nine inches apart in the rows. After planting those of one size, then another batch a size less was handled. This selecting into sizes pays for all the trouble it costs in preventing strong plants from overcrowding the weaker ones. My soil is rather a heavy sandy loam, and in this the bulbs were planted, the depth of the entire bed being a little more than four inches. The bulbs were scarcely covered even at this time, and this, I find, prevents the damping off of the plants during dull days, when they have commenced to grow rapidly, and are checked either by dark weather or by a cold spell. By the middle of March each plant was tied securely to prevent its falling over, which is generally ruinous to the flower-spike; a light mulching of stable-manure was then put on and well watered. From that time until the flowers were cut a good soaking of liquid manure was given each week. The gladiolus delights in moisture when well along in growth, but in its earlier stages too much water is death to it. The first twenty-five flowers were cut for Easter, or six weeks earlier than last year. The temperature was never higher than 50° at night, and during the daytime the house was ventilated whenever it could be kept above 70° F.

Another object of indoor culture is to extend the season of bloom in the conservatory. For this purpose the method of culture described by Kelway (1913) is substantially as follows: If it is desirable to have gladioli late, for decorating the conservatory, they may be grown with tolerably good effect. The corms should be potted singly in six-inch pots about the end of May, using a rich compost of yellow loam, old hotbed manure, and silver sand. They should then be plunged in a bed of very rich soil the rims of the pots being placed about two inches below the surface. In dry weather they will require to be kept tolerably moist with frequent waterings. As soon as frosts commence the pots should be lifted and placed in a cold greenhouse or vinery, and they should be brought into the conservatory as soon as the buds begin to open.

It is frequently recommended that some bulbs be potted of such varieties as are useful early in the spring or summer, four or five corms being placed in a six-inch pot and started in a temperature of 50° F. These can later be planted in the ground, and four or five weeks can thus be gained in blooming. Often, however, this method does not prove successful. It is difficult to handle the plants without breaking the tops, and they should be staked immediately on being placed in the garden.

### INSECT AND ANIMAL PESTS

It seems safe to say that there is really no insect that is seriously injurious to the gladiolus. Dombrain (1873) reports serious damage in England due to wireworms. He believes that freshly turned-up sod should not be used, and writes as follows: "Three years ago I planted mine in a part of my garden which had up to two years before that been a meadow, and the previous season had potatoes in it. Half my roots



were devoured by wireworms, the destructive little things eating through the shoot just as it appeared above ground." W. P. Wright also mentions wireworms, in *Popular Garden Flowers*. He states that the grubs fasten on the corms in myriads, and soon make short work of a large collection. He recommends that if the corms are planted on new land from pasture, the turf should be taken away, not turned in, however deeply, and in the spring before planting Vaporite or Aporite should be dug in nine or ten inches below the surface.

The writer has seen no reference to injury from wireworms in this country. Weathers (1911) recommends trenching three feet deep in autumn, burying the topsoil containing the worms, and perhaps other grubs, at the bottom of the furrow. By this practice the worms are completely stifled and deprived of their vegetable diet; the subsoil will thus be free from the pest, and if well manured and exposed to the weather it will be in a good fertile condition in the spring.

The writer has noted a slight amount of injury due to the small wiry millepede, a Chilognatha. This may be the "wireworm" already referred to. The millepedes may be observed in the ashes under pots of gladioli grown indoors, and many of them are also noticed on the outdoor corms at the time they are being overhauled for winter storage. The condition known as scab may be due to these millepedes, but this is not definitely proved. If the corms are left to dry in a barn for some time, the holes bored by the millepede are filled with a jelly-like substance which one might at first think is frost. The injury due to these millepedes differs from diseased corms in that the areas of their attack are of regular shape and are metallic in appearance.

Most of the damage to gladioli caused by insects is on the parts of the plant above ground. The black aster beetle seems troublesome to many growers, the damage being to both buds and flowers. This is especially true late in the season.

H. A. Richardson reports the occurrence of arctiid moths, undoubtedly a species of the genus of tiger moths, *Eyprepia*. These moths are gregarious in habit, and they injure the flowers and spikes, but mostly the cuticle of the leaves. Grasshoppers and katydids have been reported as eating the blooms.

The red spider (*Tetranychus telarius* Linn.) is especially troublesome in a very dry season. This is a small mite, one-fiftieth of an inch long, which spins minute threads that are scarcely perceptible to the naked eye but that when very abundant give a grayish appearance to the leaves. The insects are rather reddish, though somewhat orange-tinged. Their principal injuries are to indoor plants, but they are also found in the open. When only a few are present they are not noticeable; but when

they are abundant, the leaves become pale in color and stunted. They effect their injury by sucking the juices from the leaves. Indoors they are more resistant to fumigation than are aphids or thrips. As they are very sensitive to moist conditions, the main method of control is by a thorough syringing with water. Sanitary methods of keeping down all weeds harboring them, and burning infested parts of the plants, are of prime importance.

A number of cases of injury by a black blister beetle have been reported. This is no doubt a beetle of the genus *Epicauta*, or possibly *Meloe*.

Van Fleet and others report the occurrence of a *Diabrotica* beetle. These are yellowish green, much like the cucumber beetles. On the trial grounds at Cornell they caused some injury by eating the unopened buds. If very plentiful they may be shaken on to sticky paper, as recommended by the California State Commission of Horticulture.

In *Success with Flowers* (Anonymous reference, 1901), a subscriber who inquires as to effective treatment for a root aphid, or root louse, which it is difficult to reach with insecticides, is answered as follows:

The piece of ground to be planted with gladiolus may be cleared of the insects by the use of coarsely ground tobacco that can be purchased at about ten cents a pound. A heavy dressing of the tobacco can be spread on the ground and forked in immediately before planting, or it may be dug in between the plants later in the season. . . . Potash salt in the form of kainit has been found to be injurious or destructive to the insects; nitrate of soda produces similar effects. If, therefore, these substances should be used as fertilizers, . . . they would at the same time destroy the pests, or at least lessen their number to the extent of rendering them harmless.

Cutworms have been especially abundant of late. They are the nocturnal larvæ of owl moths, and according to Powell (1915) "start their depredations early in May, or even in late April, and continue until about the middle of June." The best remedy seems to be a poisoned bait made in one of various ways. For small garden spots a little paris green is mixed with some bran, the mixture then being made into a thick mush by the addition of sufficient molasses and water. This is sprinkled along the rows of gladioli. Munroe (1915) states that when large fields need to be treated, it is best to spread the bran, perhaps about a hundred pounds, on a barn floor, and sprinkle it with sweetened molasses water (enough to make it crumbly); over this is then scattered a pound of paris green, and the whole is mixed together thoroughly.

### GLADIOLUS DISEASES<sup>s</sup>

Dr. L. M. Massey, of the Department of Plant Pathology, Cornell University, contributes the following brief résumé of the gladiolus diseases:

<sup>s</sup> The Department of Plant Pathology at Cornell University is investigating the diseases of the gladiolus, and all samples of diseased plants or corms, as well as all correspondence concerning treatment for the prevention of disease, should be addressed to that department.



There are at least three important diseases of the gladiolus, namely, hard rot, dry rot, and scab. The first two are characterized by necrotic lesions of various sizes in the corms, the diseased area blending more or less gradually into the healthy tissue. Scab lesions have a sharp line of demarcation, a distinct ridge being formed around the border of the depression. The surface of the depression has a somewhat metallic luster. In the older scab spots there is a cavity beneath the metallic film, appearing as if eaten out by some insect.

The lesions of hard rot and dry rot are usually small in the autumn, when the corms are dug. The diseases advance while the corms are in storage, until by spring many corms are reduced to dry mummies. Scab lesions do not enlarge after the corms are placed in storage.

Hard rot and dry rot are caused by fungous pathogenes whose life histories do not materially differ. The two fungi live over winter in the corm and are thus carried to the soil at planting time. The fungi do not grow from the old corm directly into the offspring, but either grow out into the soil, whence they attack the corms, or else work along the sheathing leaf bases. In the majority of cases a diseased corm may be expected as a result of planting one that is diseased.

The cause of the scab disease is unknown. Attempts to connect some fungus with the diseased areas on the corms have failed. The lesions may be due to the attacks of certain insects, such as wireworms or millipedes, but no experimental data are at hand to prove or disprove this suggested possibility.

Various soil and corm treatments have been used in an effort to control the hard rot and the dry rot of the gladiolus. Corms have been treated with formalin, corrosive sublimate, hot water, dry heat, and so forth, at strengths as high as the corms would permit without injury. None of these treatments have proved effective. Soil has been treated with lime, acid phosphate, sulfur, lime and sulfur, and iron sulfate, in strengths as high as the grower could afford to use them, without protecting the corms from the attacks of these fungi.

The selection of healthy corms, which are planted in soil in which no gladioli have ever been grown, is the one process that has unfailingly resulted in the production of healthy offspring. This requires a rigid selection. No corms should be planted which show any signs whatsoever of disease after the husks are removed. Care should be exercised during the growing season to see that no infested soil nor diseased plant parts are carried to the soil in which the healthy corms are growing.





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